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FRENCH FOUR-CYLINDER COMPOUND LOCOMOTIVES

Opinions Based Upon Experience.

EDITOR'S NOTE.—The remarkable results which have been obtained in France with four-cylinder compound locomotives have greatly impressed a number of American locomotive men who have investigated them. In response to requests for the facts of experience, statements have been obtained from two of the highest authorities on the subject—Mr. A. G. de Glehn, of the Société Alsacienne de Constructions Mécaniques, and Mr. A. Herdner, assistant locomotive and carriage superintendent of the Southern Railroad, in France.

These gentlemen treat the subject in a way which suggests the probability of successful application of the four-cylinder balanced principle in American practice. The position of THE AMERICAN ENGINEER on this subject is well known. The principle seems worthy of a thorough trial in this country. Mr. de Glehn's article is presented below, and Mr. Herdner's will follow in a later number.

THE DE GLEHN FOUR-CYLINDER COMPOUND.

By A. G. de Glehn.

As four-cylinder compound locomotives on the divided and balanced principle, which I introduced many years ago (in 1885), have steadily increased in favor, and seem now in a fair way to be tried in America and in England, I may perhaps be allowed to send you the following remarks on the subject:

The advantages of the four cylinders appear to be now generally admitted, but the two separate sets of valve-gear are still objected to in some cases, and this on the score of complication. This bugbear of complication is responsible for a good deal of confused thinking. Why! almost all mechanical progress has been by and with increased complication! A planing machine is more complicated than a hammer, chisel and file, and a Corliss engine than an ordinary engine with a single slide valve driven by an eccentric; and yet we do use planers and Corliss engines and much other complicated machinery, and are very glad indeed to have them.

When I introduced the four-cylinder compounds, the word "complication" was, of course, used to kill the new engine. What? Four cylinders! How complicated! Well, the four cylinders seem to have proved their right to existence, in spite of the complication, and now people say: "Four cylinders are all very well; but two separate sets of valve-gear—that is too much of a good thing; that is far too complicated."

What does this mean? Why, merely that the results attained have seemed to justify the complication of the four cylinders, but that there is yet hesitation in some minds (principally in the minds of those who have never tried such engines) as to whether the complication of the two separate sets of valve-gear has sufficient advantages to justify its existence. In America you seem to have decided offhand and without trial that this complication is unnecessary, and have (see an article in your paper of some time since) called the separate gears the unnecessary "fringes" that adorn French locomotive design, whereas severely practical America will have none of such vanities. Now, I wish to explain why we have adopted separate distributions and the intercepting valve allowing of a direct exhaust for the high-pressure cylinders, for, whatever our taste may be in dress, we do not care more about unnecessary fringes in locomotives than you do. We introduced these complications with a very definite idea of what we wished to attain thereby, and the experience of many years, with the very large number of express engines on all the French main lines, has so far really convinced those responsible for the working of the engines that the results attained have justified the increased first cost and the very slight additional cost of and trouble in oiling. These last are the only real objections that can be urged against the two sets of valve-gear.

I may here at once state that one of the first arguments used against my new type of engine was that the cost for repairs would greatly exceed that for a simple engine. From the first I declared that this would not be the case, and experience has proved me to have been right, and it is not difficult to understand how this should be the case. A locomotive is a very hard-worked machine, and we give all its parts and, indeed, can give them, but relatively very small wearing surfaces in proportion to the work to be done, which is for many reasons, but principally because we are hampered for room, being limited in *width*, while it is just in the direction of width that lies what we want for our wearing surfaces (pins, axles, etc.), namely, length of bearing. We can give diameter, but we are limited in length. Now, by dividing the engine and the valve-gears we have doubled the number of parts, thereby halving the work each part has to do, and at the same time, owing to the peculiar location of the cylinders, we have more *room*, for the high-pressure cylinders drive one axle and the low-pressure cylinders another. This dividing of the total work over a larger number of smaller and lighter parts, and the being able to give them at the same time proportionately larger wearing surfaces, has had a very marked effect on the wear of the parts themselves, and the better division of the strain over the frames has much contributed to the general favorable result.

As regards the crank-axles—a very important question, as they are costly and were constantly breaking in the two-cylinder engines—I asked myself why they broke, with the

obvious answer—*because they have too much to do.* As it was not possible, for many reasons, to do much with advantage in the way of increased dimensions, all that remained to be done was to give them less to do. The work that a crank-axle has to do is of a very complex nature, but what greatly contributes to their breakage are the side blows of the wheel-flanges against the rails, acting with a powerful leverage against the cranks in engines with large wheel-diameters. This kind of stress and fatigue could not be reduced. All, therefore, that remained to be done was to reduce the work coming from the cylinders by giving the crank-axle only half of it to do. The result has been a very largely increased mileage for the crank-axles. Such are the principal reasons that explain the fact that the cost for repairs has not increased with the number of parts.

As regards the valve-gears, it may be objected that when using piston valves the gears have so little resistance to overcome that the available wearing surfaces for an ordinary gear are largely sufficient. As I shall recur later to the subject of piston valves, I may leave this objection unanswered for the moment. I think, then, that my assertion is justified that the objections to the two separate gears may be, as I have said before, confined to the increased first cost and the very slightly increased cost of and trouble involved in oiling.

It remains to be shown what are our gains, and then to try and decide whether, as the French say, "the game is worth the candle."

First.—With a very high piston speed it is of the utmost importance that the steam should pass from the boiler to the exhaust with as direct and straight a course as possible, having on its way as few and as slight changes of section as possible. The most cursory examination of the design of my four-cylinder compounds will show that this flow is freer and less obstructed than in the case of a four-cylinder engine with one piston valve on each side to determine the steam distribution for the two cylinders on that side; for this the necessary grid-iron openings in valves and bushings are largely responsible.

Second.—A single valve and casing determining in quick succession the distribution of high-pressure (high-temperature) steam and low-pressure (low-temperature) steam is, as Hirn long ago showed, by no means conducive to economy and a thing to be carefully avoided wherever possible.

Third—Piston valves are notoriously more difficult to keep steam-tight than flat valves. They may, without much reduction of economy, be used for the high-pressure cylinders in an engine having flat valves for the low-pressure cylinders, as is so often done in marine practice; but in locomotive work the difficulty is further increased by the need of having either compressible segments for the piston valves, which answers to the lifting of D valves, or relief valves on the cylinders, or both, with the notorious loss of steam by leakage and the additional cost of keeping them in order. A really satisfactory piston valve may yet be found, but it can hardly be maintained that it has yet been found. If steam-tight, it is as difficult to move as an ordinary D valve, and if not really tight, it is a great waster of steam. In the four-cylinder engines with separate gears and four flat valves there is remarkably little wear, the high-pressure valves being partially relieved by the receiver pressure and the low-pressure valves being only under low-pressure steam. For a large number of engines on the Western of France lines the mileage of the valves for ordinary engines is 40,000 miles, and for four-cylinder compounds, 185,000 miles.

Fourth.—The work required from a locomotive is extremely variable, and the separate gears for the high and low-pressure engines enables you to adapt yourself to the varying conditions. The drivers soon find out this for themselves (though, of course, instructions are given them), and on starting put all four cylinders in full gear by the usual handwheel, as in an ordinary engine, and soon after, by the release of a simple trigger arrangement, with the same handwheel, notch back the high-pressure gear so as to have an earlier cut-off in the high than in the low-pressure cylinders. The relative cut-off can thus be regulated to suit the various conditions with the same ease as when, in an ordinary engine, you vary the absolute cut-off. With these engines an interesting demonstration can be made of the importance of the relative cut-off. Put both gears forward so as to cut off at 40 per cent. in high and low-pressure cylinders, and after a time you will, with a given train, be running steadily, say, at 55 miles per hour. Notch up the low-pressure gear to a cut-off of 50 per cent., and notch back the high-pressure gear to 35 per cent., and the speed will rise steadily to 62 miles per hour. Fast running down hill will require a slightly different adjustment, and so on. I well know, of course, that by making a higher ratio between the diameters of the high and low-pressure cylinders the disadvantage of not being able to vary the relative cut-off diminishes, but these very large dimensions for the low-pressure cylinders have other disadvantages, and are not always convenient.

Coming now to the intercepting valve by which the exhaust from the high-pressure cylinders can be diverted from the receiver to the exhaust pipe, I may remark that the arrangement enables you to obtain an exceptionallly rapid start, as, by simultaneously introducing steam (at reduced pressure) to the large cylinders the start is effected by what answers to two engines (four cranks), one high and the other low pressure. This intercepting valve enables you to run the engine with the high-pressure cylinders alone or the low-pressure cylinders alone, in case of accident to either pair; it also enables you when starting on a bank to exert an exceptional pull. None, I think, will undervalue the marked superiority of these four-cylinder compounds over ordinary engines in their rapidity and certainty in starting and getting up speed.

Now, is it possible to figure out the exact value of the advantages claimed, so as to see how they count in comparison with the disadvantages of the increased number of parts? It would perhaps be possible under one set of circumstances and for one line or country, but then the comparison might not hold equally good for other and different circumstances. I maintain, however, that the disadvantages are limited to an increased first cost of some $400 for an engine costing $18,000, and to the very little increase of oil necessary for oiling one more set of valve-gear. As to the exact value of the advantages set forth, opinions may differ; but it can hardly be said that they are unimportant.

My experience—and the engines are by no means in an experimental stage—is that if you want to get all you can out of an engine—maximum rapidity and certainty in starting, greatest power for a minimum of weight, maximum smoothness of running at high speeds, maximum adaptability to varying circumstances (I have said but little on the important point of balancing, as I take it the advantages of this system are fully recognized as regards this capital feature in powerful engines)—you can get these, as far as our present knowledge goes, best by a four-cylinder compound, with the high-pressure cylinders outside, toward the middle of the engine, and driving one axle, and the low-pressure cylinders between the frames and the smokebox, and driving the crank-axle, and with separate gears for high and low-pressure cylinders, and an intercepting valve.

I have seen the drawings of the four-cylinder engine lately built by the Baldwin Locomotive Works, and regret to see that the system should first be tried in America simultaneously with an experimental boiler. It is always difficult to draw correct conclusions under such circumstances. I may add that the crank-pin bearing is so narrow as to be sure to give trouble from heating. Further, low-pressure cylinders are much better placed *inside* the frames, and this on account not only of the better protection against condensation, but also that they thus allow of better balancing.

You will notice that I have so far said nothing about fuel

economy, and purposely so. Though an important factor, its importance has in many cases been exaggerated, and I, for my part, have never advised the adoption of compound locomotives on the ground of fuel economy alone. What has made the success of this type of engine has been the number of advantages obtained by the use of four cylinders arranged in the particular way I have advocated. For an express engine weighing in working order over sixty-five tons, to haul in regular every-day work 370 tons behind the tender from Paris to Calais, 184 miles, in three hours and ten minutes, with one stop at Amiens, on a coal consumption of 38½ pounds per mile, must, I think, be allowed to be pretty good work. The line is by no means smooth or level, there being between Paris and Amiens a 15-mile hill of one in two hundred; then another of 23 miles of one in three hundred, and also between Amiens and Calais four hills of one in one hundred and twenty-five, one of them seven miles long. Under such conditions the engine maintains a steady speed of 56 miles per hour on the hills of one in two hundred, indicating up to 1,500 horse-power, and the maximum speed is never allowed to exceed 75 miles per hour.

To conclude: I by no means wish to imply that it may not be possible to find some better system of engine for hauling heavy trains at high speeds on a small fuel consumption without having to use a heavy engine (for we are limited to 16½ to 17 tons per axle), but in the present state of our knowledge it would seem that the particular system of which I am speaking is the best so far. This contention is perhaps justified by the steadily increasing adoption of the four-cylinder balanced compound locomotive, as shown by the fact that there are now some 1,500 engines of this type running on the continent of Europe.

BEARING SURFACE OF CRANK PINS AND CROSS-HEAD PINS.

By F. K. Caswell.

In designing locomotive crank pins and cross-head pins, the maximum bending moment is first found and the pin made of sufficient diameter to keep the fiber stress within the proper limits. The length of the bearing, however, is governed by the area required to give a certain pressure per square inch on the projected area of the journal.

With the quality of oil usually furnished by railroads, the pressure per square inch of projected area should not exceed from 1,600 to 1,700 lbs. on crank pins or 4,800 lbs. on cross-head pins. To facilitate the work of checking the projected areas, the accompanying diagram has been prepared, and is used as follows:

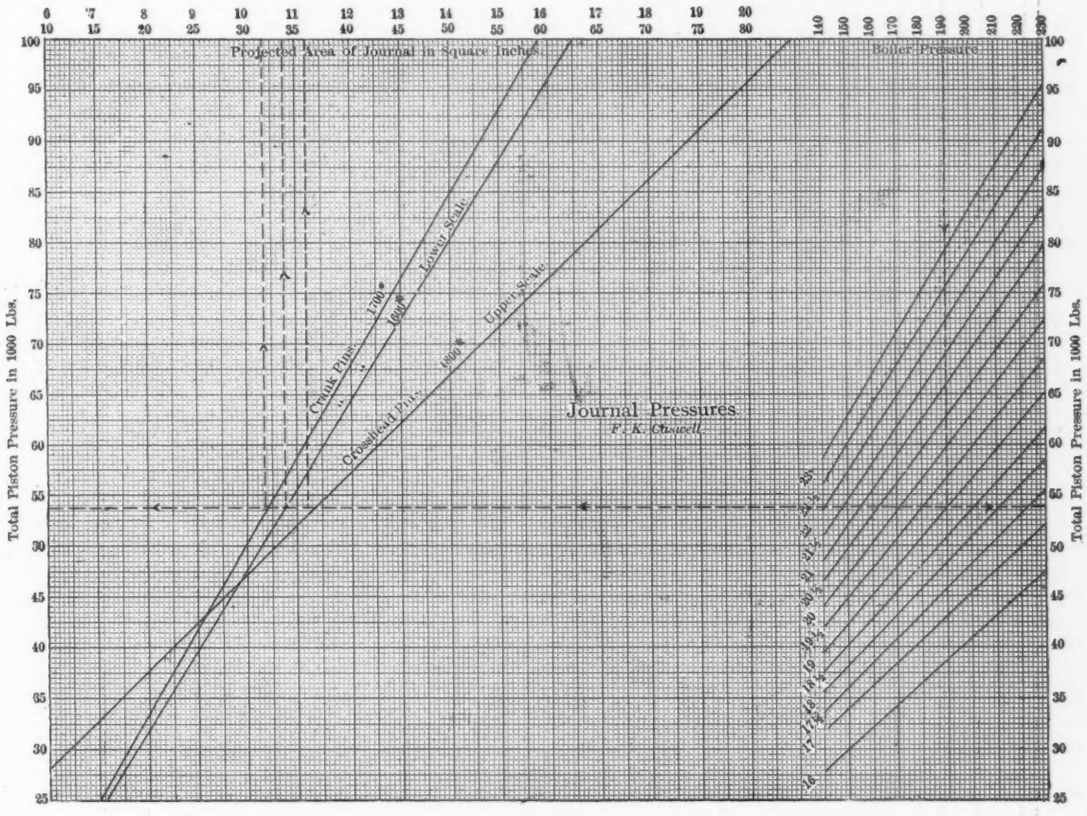
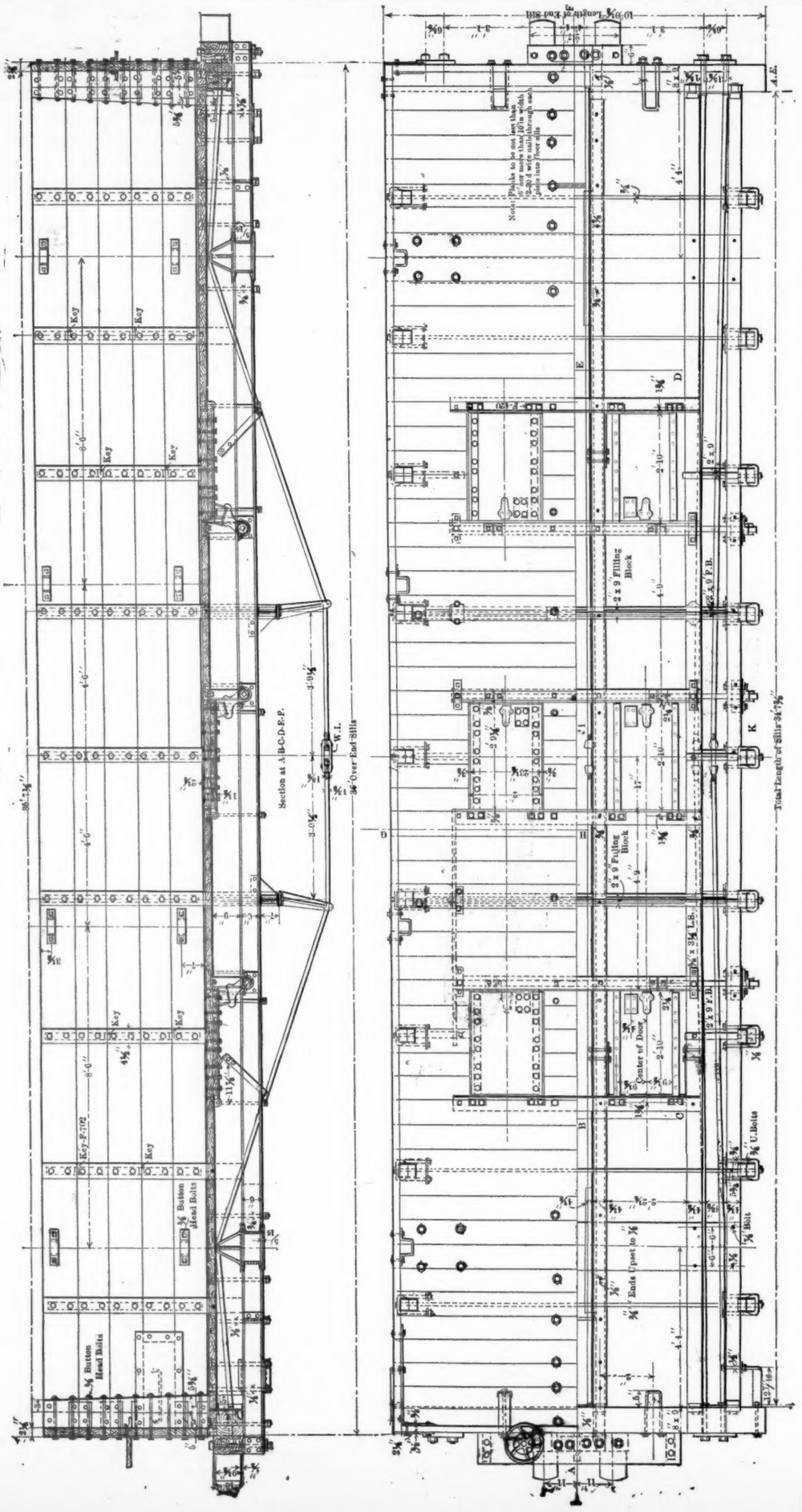


Diagram for the Determination of Bearing Surfaces for Crank Pins and Cross-Head Pins.

Starting at the upper right-hand corner of the chart with any given boiler pressure, as for example, 190 lbs., follow the line of pressure downward until it intersects the diagonal of cylinder diameter, which in the case of a 19-in. cylinder, would give a total piston pressure of about 53,600 lbs. The latter being read on the scale at the right or left-hand side of the chart.

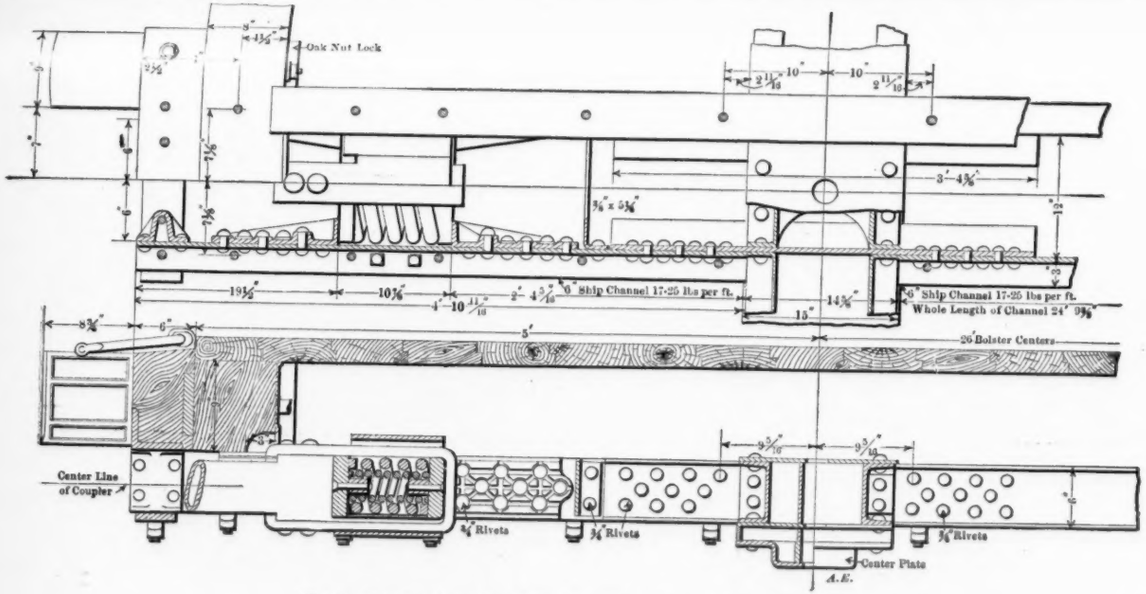
Follow the horizontal line of total piston pressure until it intersects the diagonal for the desired maximum pressure per square inch of projected area, and then, vertically above that intersection, read the minimum projected area allowable with the given pressure per square inch.

The use of this diagram in connection with a similar one for finding a maximum fiber stress has been found to save considerable time where many calculations of this kind have to be made.

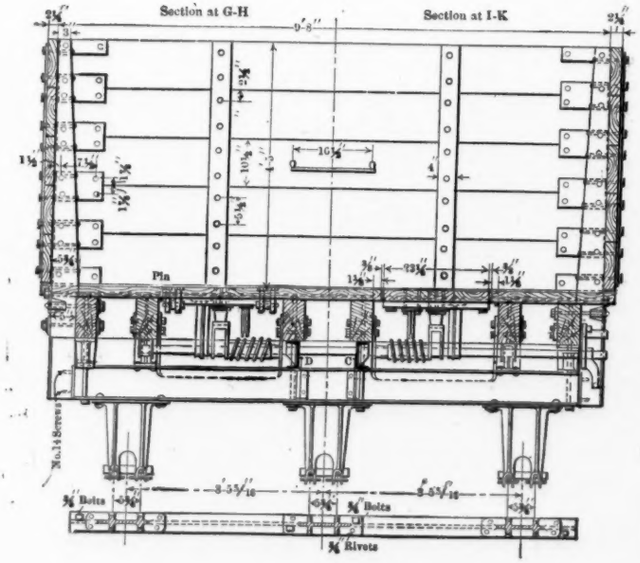


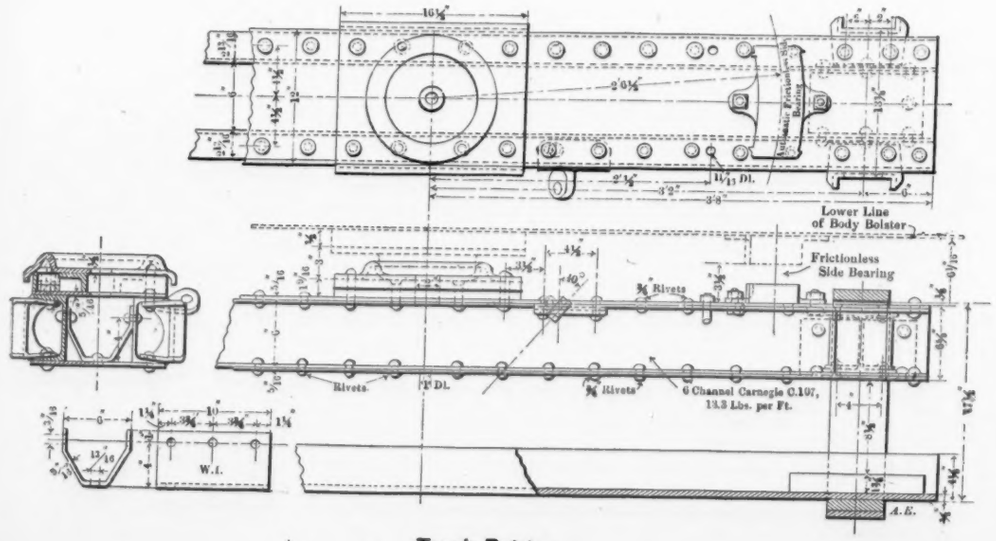
90,000 Pounds Capacity Gondola Car with Steel Draft Frame and Roller Side Bearings.—Lake Shore & Michigan Southern Railway.

H. F. BALL, *Superintendent of Motive Power.*

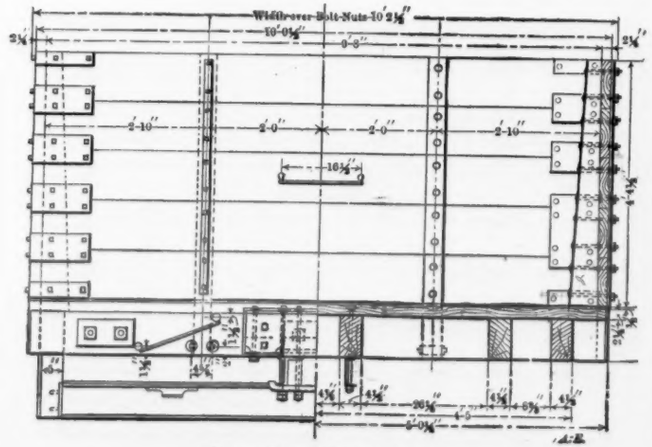


Draft Gear, Showing Attachment to Steel Draft Sills.





Truck Bolster.



Cross-Sections of Car.

90,000 Pounds Capacity Gondola Car.—Lake Shore & Michigan Southern Railway.

H. F. BALL, *Superintendent of Motive Power.*

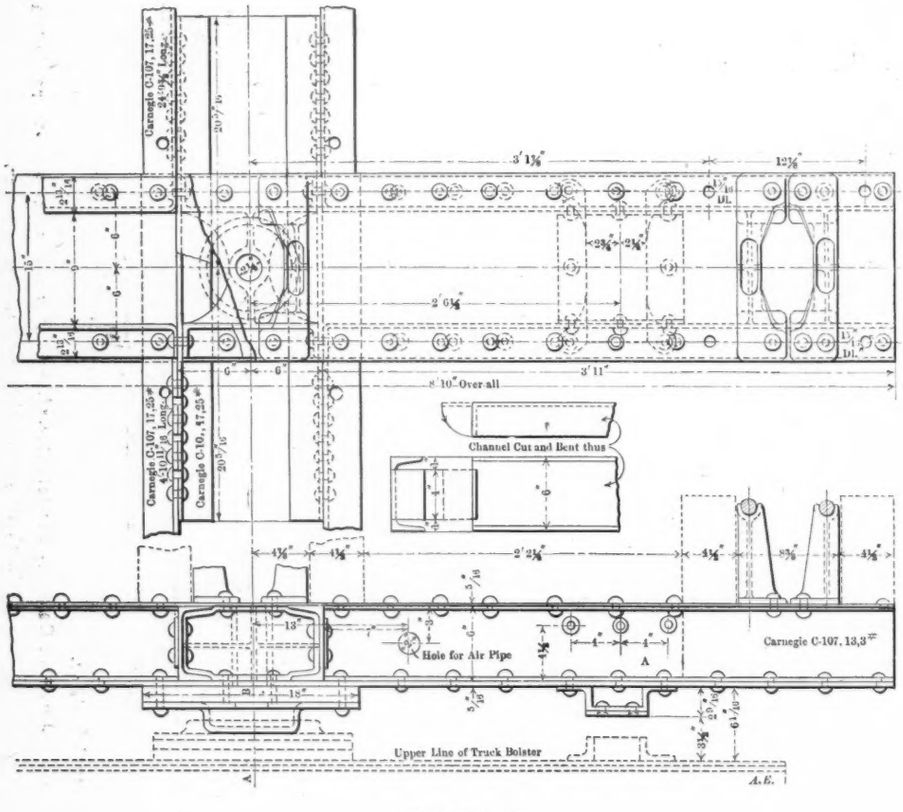
90,000-POUNDS CAPACITY GONDOLA CAR.

Lake Shore & Michigan Southern Railway.

Steel Draft Frame and Roller Side Bearings.

The chief interest in this car lies in the use of roller side bearings arranged to permanently carry 88 per cent. of the load. It has very light body and truck bolsters and a steel draft frame. The six drop doors were provided to meet the needs of shippers and to save the cutting of the floors in unloading. Thus far only one of these cars has been built.

Aside from the question of side bearings provision for the eccentricity of the draft and buffing stresses in the usual construction led to the employment of the steel draft sills, which are 6-in. channels, continuous between the bolsters. The drawings of the draft gear and body bolsters illustrate the arrangement of these parts with reference to the steel draft sills. The



Body Bolster.

90,000 Pounds Capacity Gondola Car.—Lake Shore & Michigan Southern Railway.

body bolsters are built up of two 6-in. channels with top and bottom cover plates, suitably braced at the center plates. They are very light, and this illustrates the advantage of placing the side bearings in contact. The truck bolsters are also very light, being built of two 6-in. channels with cover plates. Seven inch I-beams are used for cross-tie timbers.

In order to build the car as wide as clearances would permit the grab irons are set in at the ends. One 10-in. plank in the siding is cut out and the handle is secured to a plate placed on the inside of the opening. The car will hold 90,000 lbs. of coal and is designed for a 10 per cent. overload. The trucks are the diamond type with 5 x 9-in. journals. The roller side bearings used are the well-known product of the Chicago Railway Equipment Company. This car has Southern pine sills, side planks and floor; if Norway pine had been used, as was intended, the weight would have been from 1,500 to 2,000 lbs. less. The weight and its distribution is as follows:

Weight of body, light	36,700 lbs.
Weight of lading	99,000 lbs.
Weight, total	135,700 lbs.
Deduct weight of trucks	13,200 lbs.
Weight of car and load	122,500 lbs.
Weight carried on side bearings	107,800 lbs.
Weight carried on center plate	14,700 lbs.
Weight of body bolsters, each	900 lbs.
Weight of truck bolsters, each	570 lbs.

We are indebted to Mr. H. F. Ball, Superintendent of Motive Power of this road, for the drawings of this interesting car.

ELECTRIC CAR LIGHTING IN GERMANY.

Electric lighting for railway cars is meeting with considerable favor in Germany. Many experiments and continued tests have been made by the Prussian railway engineers on the different systems of electric car lighting, namely, sets of storage battery on each car charged, either at intervals at permanent charging stations, or intermittently by axle-driven dynamos on each car, and also direct lighting by current furnished from a single dynamo permanently located on the train. The individual axle-driven dynamo and storage-battery unit on each car, which is, theoretically, the ideal system, owing to the independence of location of the car as well as its length of run, has been discarded, owing to three defects thought to overrule its advantages, namely (1) increase of the already very heavy load on the locomotive, owing to the power taken from the axles; (2) large space occupied and dead weight added by dynamo, regulating-apparatus and accumulators, and (3) jarring and grinding noise of the gears and dynamos which annoy the passengers.

The use of storage battery units charged from permanent charging stations has, in spite of its advantages, been ruled out by the necessarily great weight of batteries large enough for long runs, and also by the delays involved in charging. As a result, the Prussian State railway administration finally settled on the direct system of lighting from a single generator, which system has, however, been modified in that the steam-driven dynamo is located upon the locomotive, under the control of the engineer, and also auxiliary or regulating storage batteries are placed on each car of the train, thus rendering each car of the train practically an independent lighting system, its lights being ensured a constant supply of current from its own accumulators, which accumulators are kept charged by the dynamo on the locomotive. It is stated that this combination meets more perfectly than either of the others the requirements of simple, economical and efficient construction, maintenance and attendance in regular service. The first practical tests of this system were so thoroughly satisfactory that other trains are now being equipped, and it is thought that a satisfactory system has been found.

ECONOMY DERIVED FROM REHEATING COMPRESSED AIR.

Tests Performed by W. G. Edmondson and E. L. Walker, Students in the Railway Engineering Department of Cornell University.

It was the object of the experimenters in these tests to ascertain the exact gain derived from reheating compressed air used in small motors, with the idea also that some such method as this could be advantageously put into application in connection with the use of compressed air in railroad shops, mines, etc., where compressed air is extensively used.

A small 2 h.p. vertical engine with a shaft governor was used as the motor. The compressed air coming from the compressor was first passed through a meter, and then before being admitted to the engine was passed through a reheater. The arrangement of the apparatus is plainly illustrated in the accompanying diagram. The amount of air used in each run was recorded by the meter, which was furnished for the test by the Equitable Meter Company, of Pittsburgh. The meter was especially designed to withstand high pressures. The air passed through the meter at the temperature of the atmosphere. The meter was calibrated for the pressures used in the experiments, before and after the runs were made, and the meter readings were then corrected from this calibration. The results therefore show accurately the amount of air used in each case.

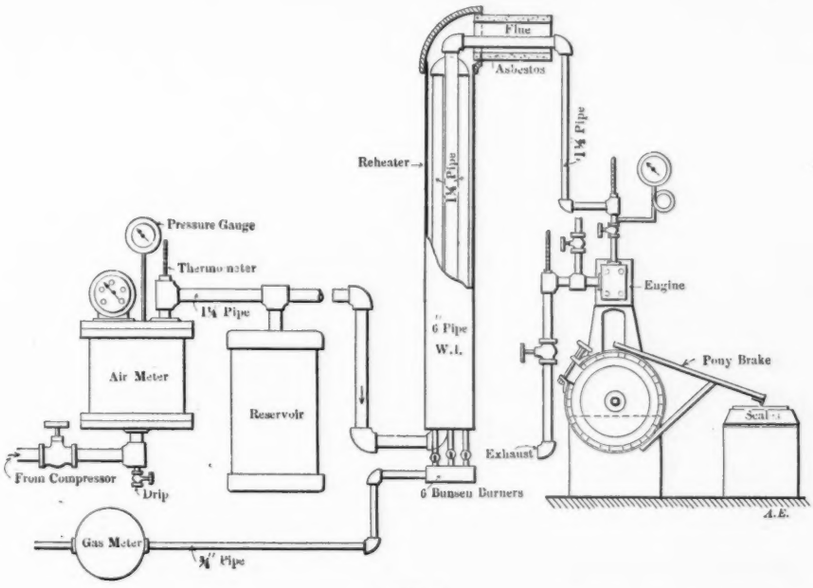


Fig. 1.

General Arrangement of Apparatus Used in Tests with Reheated Compressed Air.

The reheater was constructed out of pipe. It consisted of a coil of three lengths of 1¼ in. wrought iron pipe, which was surrounded by an outer casing of 6-in. pipe. This casing was also covered with an asbestos non-conducting covering, which prevented the escape of heat. The construction of this reheater is indicated in the diagram. Gas was used as the fuel, and was burned in a burner placed at the base of the reheater. Gas was selected as the fuel on account of the ease with which the supply of heat could be governed. A gas meter recorded the amount of gas used in each run so that the amount of heat supplied to the reheater could be easily computed when the heat value per cubic foot and the number of cubic feet of gas supplied per hour were known. The engine was equipped with a prony brake, and an indicator was attached to the cylinder, which enabled both the D.H.P (brake-horse-power) and the I.H.P. (indicated-horse-power) to be computed. In every case the temperature of the air was taken at the meter, and again after it had passed through the reheater, at a point as near to its entrance to the engine as possible.

In conducting the experiments three series of runs were taken as follows:

Series I.—In which six runs were made, all at about 57 lbs. gauge pressure, while the temperature of the air entering the engine was varied from 60 deg. F. to 401 deg. F.

Series II.—In which five runs were made, all at about 82 lbs. gauge pressure, while the temperature of the air entering the engine was varied from 60 deg. F. to 395 deg. F.

Series III.—In which two runs were made, at about 77 lbs. gauge pressure, and the temperature of the entering air 42 deg. F. and 266 deg. F. respectively.

The average results from each "run" were then taken from the log of each run and are shown on the general result sheets, one of which is reproduced. The tests were performed during the month of April, 1902, in the Mechanical Laboratory of Sibley College, Cornell University.

The term "cubic feet of free air" is used to represent the volume of air at standard conditions, which are taken in this case to be at a pressure of 14.7 lbs. absolute, and at a temperature of 60 deg. F.

Results and Conclusions.

The net gain in economy obtained with the lower pressure was 38.4 per cent., while with the higher pressure it was but 31.7 per cent. under the same conditions. In other words, we get a reduction of from 31 to 38 per cent. in the cost of the production of compressed air for a plant by reheating the air from 60 to 400 deg. F. before using it.

The curves in Fig. 4 illustrate how the economy is raised by increasing the temperature. It is seen that the increase in economy is gradually lessened after the temperature reaches about 300 deg. F. By continuing the curve it would indicate that the point would soon be reached where an increase in the temperature would not cause any further increase in economy, this point being reached at about 450 deg. F.

The results obtained in these experiments afford a very interesting comparison of the effects produced by different degrees of reheating, as well as by the use of different working pressures. Of the three different series of runs taken, the one employing the lowest pressure (56 lbs.) seemed to give the most efficient results.

It was not considered advisable with our engine to raise the temperature of the entering air much above 400 deg. F., on account of the bad effect it would have on the packing in the valve rod and piston rod glands, and also on the lubricant; however, a much higher temperature could have been attained with the reheater used.

Although the economy derived from the application of heat to the air may result from the increased volume, yet we are led to believe that the high results obtained are due partly to other changes of condition in the working of the engine, resulting from the higher temperatures. By reheating the air the engine is relieved from the difficulties due to freezing of the moisture in the exhaust passages and the choking up of the valve.

It was noticed that as the temperature of the air was raised while the pressure remained constant, the speed of the engine was increased, the cut-off was made shorter, and in general the operation of the engine was rendered much more smooth.

The results obtained from the tests appear to be approxi-

mately those which are indicated theoretically with the same conditions, and prove conclusively the many advantages to be gained by reheating, which was the object of this investigation.

For instance, it is seen that the reduction in the air consumption of a small motor is in almost direct proportion to the increase in temperature. By referring to the curves in Fig. 2 it is seen that the decrease in consumption of air is in almost direct proportion to the increase in temperature, until the higher temperatures are reached, when the decrease becomes more gradual, and finally ceases when the temperature is raised above the limit of practicability.

In Series I., which employed a pressure of about 56 lbs., it is seen that a saving of 44.6 per cent. of the air used cold was effected by reheating it from the temperature of 59 deg. F. to 401 deg. F. With Series II. and III., in which higher pressures were used, the gain was not quite as much on account of the lower efficiencies which always accompany higher pressures with compressed air. As shown by item No. 44, on the which indicates that the power derived from the same weight of air would be increased about 78 per cent. by reheating it from 60 deg. F. to 400 deg. F. In other words, a compressor which is able to supply 100 h.p. at the motor with cold air could be made to supply 178 h.p by the use of reheaters.

As the increase in volume obtained by raising the temperature of the air from this amount is only 65.3 per cent. it will be observed that the increased saving must be due partly to the more favorable conditions that the heated air provides for the engine to operate under.

The percentages of gain given in the results refer to the brake horse power, and the increased mechanical efficiency caused by the use of heated air must have a considerable effect upon the results. The increase in mechanical efficiency is shown by the curves in Fig. 3.

Thus three important points are secured by the use of a reheater, viz.:

1. Absence of freezing;
2. Reduced cost of plant throughout; and

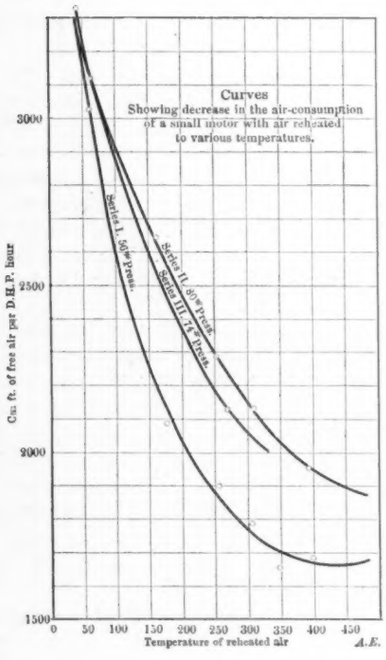

Curves
Showing decrease in the air-consumption of a small motor with air reheated to various temperatures.
Series I. 56# Press.
Series II. 60# Press.
Series III. 74# Press.
Cu. ft. of free air per D.H.P. hour
3000
2500
2000
1500
0 50 100 150 200 250 300 350 400 450
Temperature of reheated air
A.E.

Fig. 2.

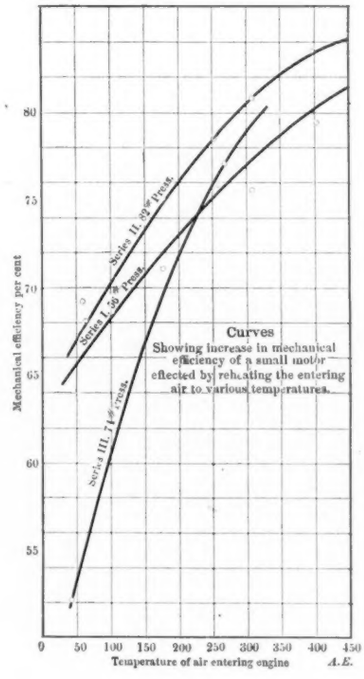


Fig. 3.

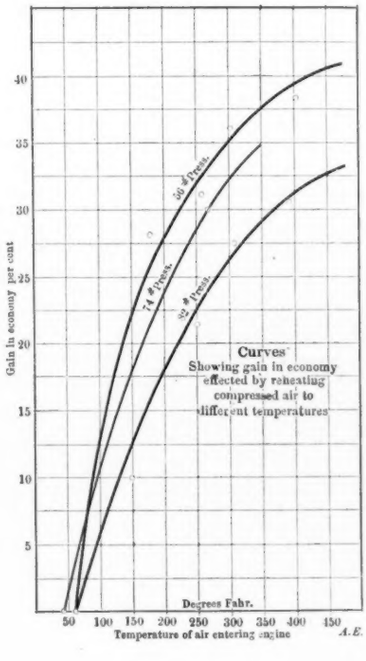


Fig. 4.

Tests with Reheated Compressed Air.

Table of Results, the results obtained by applying heat in this manner to compressed air, are from 8 to 18 times more important than would be obtained if the same amount of heat were expended under the boiler back of the compressor.

The results obtained in these experiments may be represented clearly by means of a simple proportion. Referring to the results obtained in Series I., we find that the maximum gain in air saved with the highest temperature is 44 per cent. of the amount of cold air required to produce the same amount of power.

Let us assume that 300 lbs. of compressed air at 60 lbs. pressure are required to produce 1 h.p. per hour at 60 deg. F. Then if we reheat this air to 400 deg. F. we effect a saving of 44 per cent., and we will then require but (100—44) = 56 lbs., per h. p. hr. At this rate if we take 100 lbs. of cold air and reheat it to the above temperature the increase in the power produced will be:

56 : 100 :: 100 : x.

Whence x = 178.6;

3. Great increase in permanent economy.

GENERAL RESULTS.—SERIES I.

1. Number of run	1	2	3	4	5	6
2. Length of run, hours	1	1	1	1	1	1
3. Barometer	29.41	28.97	28.89	28 89	29.0	29.32
4. Gauge pressure at meter (corrected)	57.6	55	55.4	57.8	58.7	58.7
5. Gauge pressure at engine	55	53	53.8	56	57	57.0
6. Temperature at meter	51.2	86.8	86.3	79.1	81.8	74 8
7. Temperature at engine	59	176.5	256	306	348	401
8. Temperature of exhaust air	7	87.6	147	177	198	236
9. Temperature of room	48	79	83	78	76	70
10 Temperature of flue in heater	..	220	309	352	..	421
11. Cubic feet of air per hour from meter	371	319.5	300	270	248.5	234
12. Cubic feet of air per hour corrected from calibration of meter	377	323.4	303.4	274.4	252.6	238
13. Cubic feet of air per hour at standard conditions	1,877	1,445	1,367	1,293	1,204	1,150
14. Increase in temp. of air by heating	..	89 7	169.7	226.9	266.5	326 7
15. Corresponding increase in vol., per cent.	..	16.4	31.0	42.0	49.4	61.1
16. Weight of air supplied per hour, lbs	143.5	110 4	104.4	99.0	92.2	87.8
17. B. T. Us. absorbed by air per hour	2 659	2,350	4 210	5,340	5,840	6 820
18. Cubic feet of gas per hour from meter	..	9.5	16.5	22.2	..	28.8
19. Cubic feet of gas per hour, actual	..	8.7	15.7	21.4	..	28
20. B. T. Us. contained in 1 cu. foot of gas	530	530	530	530	530	530
21. B. T. Us. supplied to heater per hour	..	4,615	8,320	11,350	..	14,840
22. Efficiency of reheater	..	51.0	50.6	47.1	..	45.9
23. Average cut off head and crank, per ct.	56	86.5	85	82.2	30.4	28
24. Average ratio of expansion	1.79	2.74	2.86	3.11	3.40	3.57
25. Range of temperature of air in engine	52	88.9	109	129	150	165
26. Revolutions per minute	330.5	368	375	378.9	381.5	387.5
27. Brake load, lbs	5	5	5	5	5	5
28. D. H. P.	.629	.693	.7175	.7283	727	.682
29. I. H. P.	.909	.973	.945	.956	.910	.866
30. Mechanical efficiency, per cent.	69.2	71	75.9	75.6	79.9	79.5

31. Cu. feet free air used per D. H. P. hour..	3,030	2,085	1,901	1,790	1,658	1,688
32. Cu feet free air used per I. H. P. hour..	2,650	1,480	1,446	1,355	1,330	1.398
33 Cu. ft. free air used per D. H. P. per min.	50.5	34.75	31.75	29.86	27.7	28.15
34. Pounds of air used per D. H. P. hour	228	159.3	145.5	137	127	128.9
35. Cu. ft. of free air saved per D. H. P. hr..	..	945	1,129	1,240	1,372	1,352
36. Gain in air saved, per cent.....	0	31.2	37.25	40.9	45 25	44.6
37. Equivalent H. P. from heater per hour..	0	.196	.258	.296	.329	.304
38. Percentage of power from heater	0	31.2	82.25	40.9	45.25	44.6
39. Heat equivalent of work done per hour (I. H. P.).....	2,315	2,485	2,450	2,436	2,320	2,190
40. Work done per pound of air, adiabatic expansion (n = 1.408), B. T. U....	9,170	5,130	5,000	4,690	4,600	4,630
41. Efficiency of the fluid, per cent	25.3	48.5	49.0	51.8	50.4	47.2
42. Thermal cost of air saved per D. H. P. hour B. T. U.....	..	6,670	11,600	15,700	..	21,800
43. Thermal cost of equivalent amount of air from compressor B. T. U	..	131,500	157,000	172,500	191,500	188,500
44. Ratio: Cost of air by compressing / Cost of air by heating	..	19.7	13.5	11.0	..	8.62
45. Thermal cost of air from compressor in B. T. Us. per D. H. P. hour.....	415,000	292,000	264,200	249,000	231,000	234,000
46. Total thermal cost of air used per D. H. P. hour	415,000	298,670	275,800	264,700	..	255,800
47. Gain in economy, per cent.	..	28.1	31.2	36.8	..	38 4

A modern boiler shop is far different from its congener of half a century ago, in that, for one thing, the methods of construction have been greatly simplified and improved tools are in more general use. These last have also reduced costs so much that an old-timer revisiting the shop would stare in amazement at what is now possible. It is not generally known that a boiler of forty horse-power can be made and shipped in about eight hours. That is to say, if an order is put in by 7 o'clock in the morning it can be on its way to its destination by 3 o'clock of the same day, ready for steam when set. This boiler will be taken from the flat sheets, rolled to dimensions, all rivets driven, tubes set and rolled, and the work made water and steam tight within the time named; but it will be of the return-tubular type, where no smith work or flanging is required. This is quick work, and I know of one shop where it is done; doubtless there are others.—Egbert P. Watson, in *Engineering Magazine.*

The New York, New Haven & Hartford Railroad is having two very large steel car floats built by the Fore River Ship and Engine Company at its yard on Quincy Point, Boston harbor. Each barge is to have three tracks, with room on them for setting 23 50-ton cars at one time. Steel construction was adopted in preference to wood because of the protection against accident which it affords.

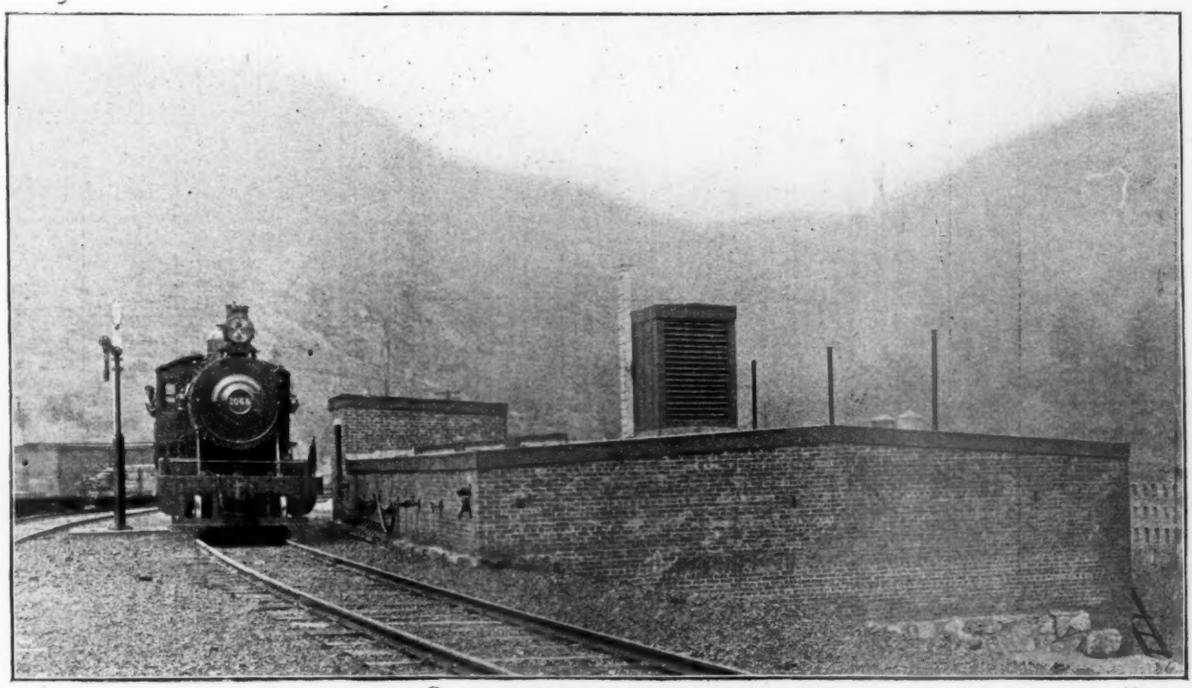
OIL-STORAGE STATION.

Hoosac Tunnel.

Boston & Maine Railroad.

In the June and July issues detailed descriptions appeared of the equipment of the Hoosac tunnel helper engines, on the Boston & Maine Railroad, for oil burning, including drawings of the firebox arrangement and details of the burner. Results comparing oil and coal will be presented upon the conclusion of tests which will soon be made.

The oil-storage station is located in an isolated spot near the east portal of the tunnel, and consists of a masonry vault built for the storage tanks below the ground-level, in order to prevent spreading of the oil in case of accident or leak in the tanks. The accompanying engraving shows the exterior of the storage station, together with one of the oil-burning engines in position alongside the standpipe for taking oil. The



View of Station Showing Oil Burner Engine in Position Alongside Standpipe for Taking Oil.
Oil Storage Station—Boston & Maine Railroad.

station contains three cylindrical tanks, 30 ft. long by 10 ft. diameter, each of a capacity of 17,000 gallons, making a total capacity of 51,000 gallons, which is sufficient to supply four of the helper engines for about two weeks, working day and night.

The piping is so arranged that the three tanks may be used as a unit or separately, as desired, so that different grades of oil may be kept in storage without danger of mixing. The tanks are filled through the "storage line" of 4-in. pipe from the two inlets shown at A and B in the accompanying diagram of the station, piping and standpipe, which inlets are alongside the tracks upon which the tank-cars stand to be emptied; so that two tank-cars may be unloaded simultaneously. The flow of the oil to the various tanks is controlled by the valves C, D and E, the handles of which extend outside the building. At the bottom of the pit there is an "equalizing line" opening through the valves F, G and H, to the various tanks, so that they may be connected together as one and their levels equalized, or kept separate. At the track end of the pit there is a "suction line" of 4-in. pipe, by which oil may be pumped from

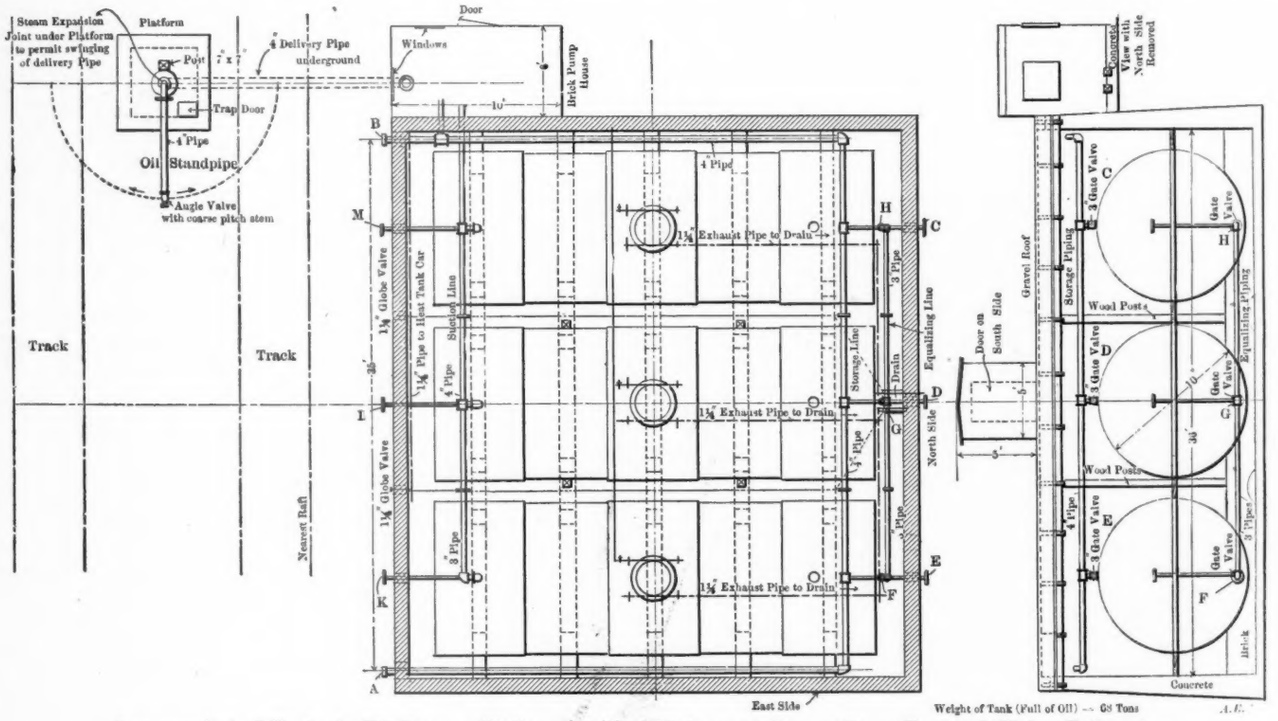
any one of the tanks desired by means of the controlling valves K, L and M, also conveniently arranged with their handles outside the building.

One of the principal features involved in the design of this station is the arrangement whereby no constant attendant is required, which is secured by an ingenious arrangement of a steam pump so connected as to force the oil from the storage tanks through the standpipe into a tender tank by steam temporarily furnished through a hose connection from the locomotive being filled. As shown in the engraving, the storage station is located on a level lower than that of the track, so that the storage tanks are filled by gravity, and the pump is needed only in supplying the locomotives.

The pump, which is a low-service duplex pump, is located in the small pumproom shown adjoining the station on the west and near the track, and pumps from the "suction line" into the standpipe connection, having a capacity of about 1,000 gallons of oil in five to ten minutes. The steam taken from the locomotives to run the pump is reduced to a pressure of about 30 lbs. by a reducing valve before entering the pump, has a chain attached running up to the manhole; then, by merely uncoupling the unions UU, which connect the ends of the coil to the pump and exhaust, the coils may be pulled out through the manhole without emptying or otherwise disturbing the tank. The oil suction pipe enters the tank through an enlarged flanged opening of sufficient size to permit it to be removed, together with the foot-valve at its lower end. A float is arranged in each tank to actuate its gauge-pointer on the roof, and each tank has a vent-pipe consisting of a hooded pipe running 10 ft. above the top of the tank. At the right of the plan of the tank is shown a corner of the storage station in section, giving the arrangement of the pump exhaust connection to the heating coils, and also the by-pass for running live steam into the heating coils.

Standpipe.

The standpipe, shown at the left of the locomotive in the engraving, is located between two tracks, so that tender tanks may be filled on either track. It is very simply constructed of standard pipe and fittings, with an ordinary steam expansion joint at the lower end, under the platform, to permit of the



Arrangement of Tanks in Oil Storage Station, Showing Piping and Connections—Boston & Maine Railroad.

and there is an arrangement of exhaust piping so that the exhaust steam may be used to heat the oil in any one of the storage tanks, or in tank-cars to be unloaded by means of heater coils. There is also a connection for heating the oil by live steam direct from locomotives. The oil-delivery pipe from the pump is fitted with a relief valve, which is arranged to divert the flow from the standpipe back into the storage tanks by excess pressure when the valve is closed at the nozzle of the standpipe. The walls of the station are of brick and concrete, and the roof, which is of timber, graveled, is surmounted by a small tower with louvres for ventilation, and a door for entrance into the station. Alongside of this tower is a gauge-board with pointers for indicating the height of oil in any one of the storage tanks.

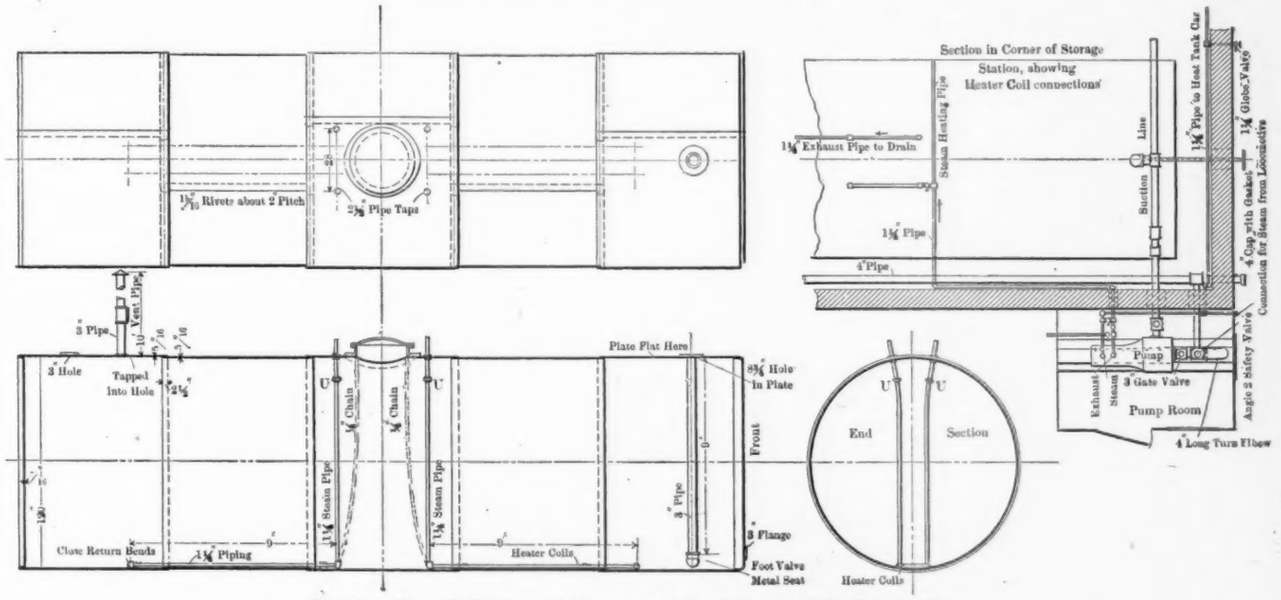
Storage Tanks.

The storage tanks, one of which is shown herewith in side and end sections, has an interesting arrangement of heater coils, of which there are two in each tank, so that they may be easily removed. Each coil, which is of parallel piping, with close return bends, lies on the bottom of the tank, and necessary swiveling of the delivery pipe, and having an angle globe valve with a coarse pitch stem at the end of the delivery pipe. The standpipe is supported by a 7 by 7-in. hardwood post, against which it is pivoted so as to swing freely. The end of the delivery pipe terminates in a funnel and strainer for conducting oil to the tender tanks, and an air-check is placed in the delivery pipe near the valve to permit the oil to drop back when the pump is stopped. This arrangement essentially precludes any danger of fire, as the oil is at all times below the level of the tracks, and as the station pit or building is large enough to hold all the oil from the tanks if they should all burst, and with this form of standpipe there is no drip of oil and not even any odor from it.

Tender Tank.

The tender tanks are rectangular closed tanks of 1,050 gallons capacity, shaped to fit into the coal space of the tender, and well braced internally to withstand an air pressure of 15 lbs. The filling hole is in the middle of the manhole at the rear end of the tank, and is covered by an air-tight lid, which may be quickly removed by simply loosening a hand-bolt, as

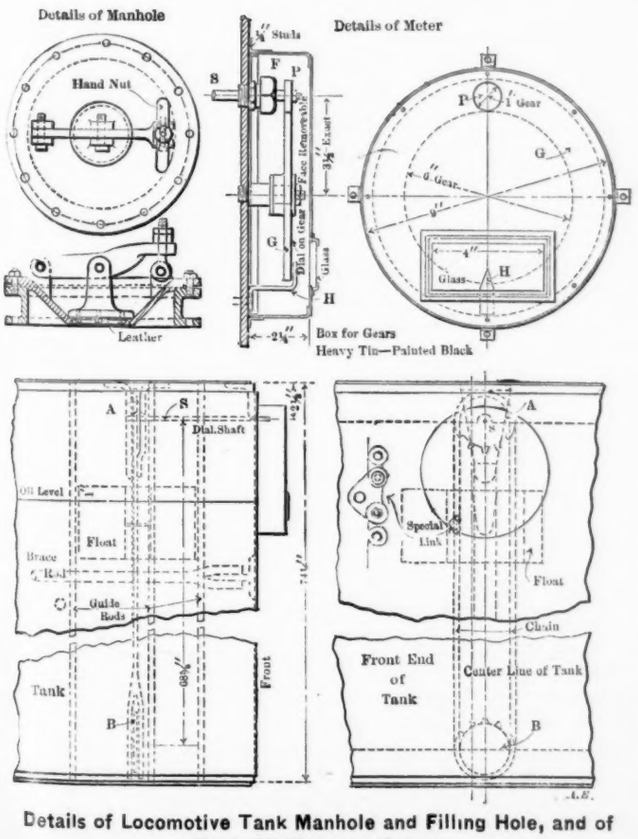
shown in the accompanying detail sketch. The burners may be fed by gravity alone, but a more uniform flow is secured by carrying an air pressure of 8 to 10 lbs. within the oil-tank, which pressure is obtained through a reducing valve from the brake-reservoir. There is a steam-heating coil in the tank near the outlet to the burner delivery pipe, in which steam is circulated at 10 lbs. pressure. The burner delivery projects 1½ ins. up into the tank above the bottom to prevent dirt from entering, and is provided with a lever gate-valve, with its handle projecting up through the tender floor, for cutting off any flow to the burner when the engine is laid up.



Construction of Tanks and Arrangement of Heater Coil Connections.

Oil Gauge or Meter.

In the determination of the amount of oil in the tank, the unsatisfactory methods of wasting air pressure in inserting a rod into the tank, or of the breakable glass gauge for indicating the oil level, are avoided by an ingenious oil meter operated by a float within the tank. This meter, which is shown in the accompanying detail view, consists of a dial which is revolved by the rising and falling of a float in the oil, as shown in the view of the front end of the tank. The float, which is guided in its movements by guide rods, is fastened to an endless sprocket chain by means of a special link, so that as it moves it carries with it the chain and thus revolves its supporting sprocket wheels. The upper sprocket A is keyed onto the dial-shaft S, which extends through the air-tight stuffing-box F, out into the meter outside the tank, and has keyed onto its outer end the pinion P. This pinion meshes with the larger gear G in such a ratio that for a total rise or fall of the float the gear G moves through one revolution, and upon the outer face of the gear there is a dial so graduated that each division represents one barrel of oil (50 gallons), so that by means of the stationary pointer H the amount of oil in the tank at any time is indicated. The lower sprocket wheel B is supported by a framework supported from the top of the tank, so that in case of a bulging of the tank due to the air pressure the chain will not be unduly tightened.



Details of Locomotive Tank Manhole and Filling Hole, and of Tank Oil Meter or Gauge.

Boston & Maine Railroad.

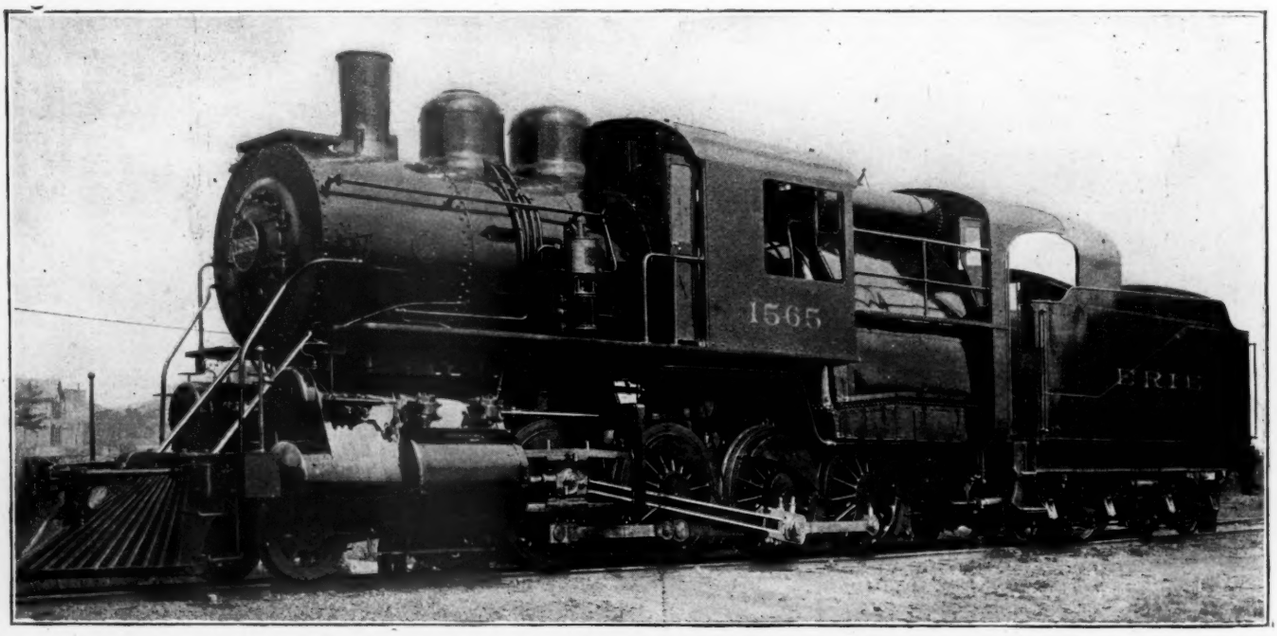
Reports from Russia give a very unfavorable account of twenty-four locomotives built for the Central Russian Railway by the Charkoff Locomotive Works. Their speed is unsatisfactory, being only eighteen miles per hour on a maximum under conditions for which fifty miles was expected. This is said to have led to the decision to buy foreign locomotives in the future, American locomotives being in high favor. With reference to this decision Mr. John H. Converse, of the Baldwin Locomotive Works, is quoted as saying: "Our establishment has been building locomotives for Russia for the last thirty years, and we have shipped no less than 419 engines of various patterns, equipped with all of the most effective and modern appliances known to the trade. The total amount of money received by our firm from Russia for these constructions is between six million and seven million dollars, and that country has always been among our best patrons."

TANDEM COMPOUND CONSOLIDATION FREIGHT LOCOMOTIVES.

Erie Railroad.

The accompanying engraving illustrates the tandem compound consolidation freight locomotives recently delivered to the Erie Railroad by the Cooke Works of the American Locomotive Company. This locomotive corresponds in wheel and cylinder arrangement to the new tandem-compound consolidation freight locomotive for the A., T. & S. F. Ry., which was illustrated on page 179 of our June issue, although the Erie engine is heavier and differs further in having a modified Wooten boiler. The heating surfaces of these two engines are, however, practically the same, that of the Erie engine, 2983 sq. ft., being only 18 sq. ft. the larger, but the tractive force of the Erie engine is considerably the greater, being 45,900 lbs., or 5,900 lbs. greater.

Among other notable features of this locomotive, attention may be called to the hand rails at the front and on the outside of the right-hand running board, and also to the arrangement of the air tanks over the fire-box, and behind the cab, two tanks, 20 1-2 by 84 ins., being located on either side of the bell and pop-valve connection. The steam using auxiliaries in the cab are connected to a special fountain, which is fed directly from the dome in front of the cab, thus ensuring dry steam.



Tandem Compound Consolidation Freight Locomotive—Erie Railroad.

W. S. MORRIS, *Mechanical Superintendent.* *Built by* THE AMERICAN LOCOMOTIVE COMPANY, COOKE WORKS.

The principal dimensions of this engine are given in the following table:

Tandem-Compound Consolidation Locomotive.
Erie Railroad.

Gauge	4 ft. 8½ ins.
Fuel to be used	Fine anthracite coal
Weight of engine in working order, total	209,000 lbs.
Weight on drivers	185,500 lbs.
Weight on truck	23,500 lbs.
Weight of tender, loaded	120,000 lbs.
Wheel base, driving	15 ft. 6 ins.
Wheel base, total, of engine	24 ft. 3 ins.
Wheel base of engine and tender	51 ft. 11 ins.

Cylinders.

Diameter	16 ins.
Stroke of piston	30 ins.
Slide valve, pattern	Piston type
Travel of valve	6 ins.
Steam ports, width	1⅞ ins.
Steam ports, length	30½ ins.
Exhaust ports	2⅛ ins. x 28½ ins.
Lap of valve high and low pressure, outside lap	⅞ in.
Inside lap, high pressure, line and line; low pressure, ¼-in. clearnce.	

Wheels, Etc.

Diameter of driving wheels outside of tire	56 ins.
Driving wheel centers, material:	Main of cast steel; first, second and fourth, cast iron
Driving wheel centers, diameter	50 ins.
Engine truck wheels, diameter	30 ins.
Engine truck wheels, kind:	Standard cast-iron center, steel-tired, with retaining rings
Driving axle journals, diameter:	Main, 10 ins.; first, second and fourth, 9 ins.
Driving axle journals, length:	Main, 12 ins.; first, second and fourth, 12 ins.
Engine truck axle journals, diameter	6 ins. x 10 ins.

Boiler.

Boiler type	Straight top, wide firebox, radial stayed
Boiler working pressure	220 lbs.
Boiler, horizontal seams	Sextuple riveted
Boiler diameter, first course, outside	70½ ins.
Boiler, thickness of shell	9-16--⅝ ins.
Boiler firebox, length	114⅛ ins.
Boiler firebox, width	96¼ ins.
Boiler, style of grate	Drop front and back, six sections rock bar
Tubes, number	369
Tubes, diameter	2 ins.
Tubes, length	14 ft. 6 ins.
Heating surface, firebox	199 sq. ft.
Heating surface, tubes	2,784 sq. ft.
Heating surface, total	2,983 sq. ft.
Grate surface	76.27 sq. ft.
Exhaust pipe	Single, high
Smokebox	Extended
Height, center of boiler from rail	9 ft. 5 ins.
Height, top of stack from rail	15 ft. 6¼ ins.
Brake	Westinghouse-American

Tender.

Frame	12-in. steel channel
Truck, style	Barber
Truck, wheel kind	Chilled cast iron
Truck, wheel, diameter	33 ins.
Truck, axle journal, diameter and length	5 x 9 ins.
Tank, water capacity	6,000 gallons
Coal capacity	10 tons

The Atchison, Topeka & Santa Fe Railway system has succeeded in reducing the dust nuisance on the arid section of its main line from Seligman, Ariz., to Hesperia, Cal., a distance of 360 miles, by liberally sprinkling the track with crude oil. The spraying will be repeated until the ballast is thoroughly saturated. The result thus far is very satisfactory; it is now possible to ride out on a back platform while the train is making sixty miles an hour and be practically free from the annoyance of dust. Also, the Santa Fe engines in California use crude oil for fuel and are cinderless. Thus the absence of both dust and cinders makes railroad traveling in that almost rainless country a matter of enjoyment instead of the reverse, and the rides down the Yampai and Hualapai valleys are no longer disagreeable.

CORRESPONDENCE.

THE CARE OF BLUE PRINTS IN THE SHOP.

To the Editor:

"A place for everything and everything in its place" finds practical application to a great extent in and about locomotive and car repair shops, as far as small tools, supplies, etc., are considered, but seems to have stopped, in a great many cases, just short of the drawings or blue prints used.

In a great many instances we find the prints kept in some sort of a case or file, and such a case in each shop or department, but no check or system is employed to tell the whereabouts of prints, everybody helping themselves. Again, in some others, we find all prints intended to be kept at one place—say the general foreman's office—but with no good system of keeping track of them. In either case, if a print cannot be found in the case or file, a search must be made, which always runs into minutes and generally a whole hour, depending, of course, on the size of the shop and the location of the cases. A moment's thought should convince any man in charge of a shop that a great deal of time is lost in this hunting for prints, and that it will never stop till some efficient means are employed to care for and to locate the prints.

Collections of blue prints are libraries of information, and should be treated as such. They should be catalogued and their whereabouts known at all times. There are two systems—one in which all prints are kept at one place, and the other in which each shop or department has cases for its own prints, depending, of course, upon the size of the shops, the number of prints, and the location of the buildings; but before any one system is adopted a thorough investigation should be made and the advantages and disadvantages of each carefully considered.

In the moderate-sized shop, where the various buildings are conveniently located with respect to each other, the first method should be used, as a rule, as it insures all prints being kept together and looked after by one person, thus insuring uniformity at the least expense. Right here the question may be asked, "How about the time spent in going from some shop to the office after a print every time one is wanted?" Of course, some time is consumed in doing this, but if several prints, say those likely to be used during a few days or even a week, be taken to the shop and all of them charged up to that shop, only one trip is taken, and the office knows just where to find them all. If this method is resorted to, too many prints should not be issued to one shop at one time, as the more prints there are in the shop the harder it is to keep track of them. Where the various shops are large and widely scattered, and the number of prints large, the second system would undoubtedly prove the better, as it would lessen the time spent in getting prints from a central point.

Where a system is adopted, uniformity in methods of cataloguing and of caring for prints should be insisted upon. In cataloguing a lot of prints, the fitness of the card catalogue cannot be questioned, as it is perfectly elastic and handy, easy to keep up, and a time-saver when compared with any book catalogue that can be devised. Prints should be indexed, or catalogued on the cards. *by the name of the detail, by the print number,* and *by the case number;* that is, there should be three separate catalogues or indexes. In indexing by the name of the detail, the cards should be in alphabetical order; thus, for cylinders, cocks, etc., we have cards under "C," axles under "A," etc. The cards of this catalogue should contain spaces for the class of engine or car to which the detail belongs, for the case or file number, for the print number, and finally spaces for the date the print was received and the date canceled. In indexing by print number, the cards should contain spaces for the print number, for the case or file number, and for the name or title of the print. This catalogue, running by numbers, will be found to be the most convenient, as print references are generally given by the number of print. In indexing by case or file number, the cards should contain spaces for the case number, for the print number, and for the name or title of the print or detail. The latter space is not absolutely necessary, since the print-number catalogue contains the name, but it will be found to be convenient, its utility coming into play when prints are lost or taken from the case without being checked, since by referring to the print-number catalogue we find the name of the print missing and are thus enabled in most cases to locate it.

To handle prints conveniently and preserve them, they should be mounted on cardboard or light sheet iron, and protected from grease and dirt by a good coating of varnish or shellac. On the backs of these boards numbers should be stenciled in large figures of such a color as will contrast with the card. These numbers should also be protected with shellac.

When necessary to remount prints, or to use discarded mounting cards for new prints, it will be found most convenient and economical to remove the old prints by holding the card over a hot fire, such as a coppersmith uses, and allowing the print to burn off. This will in no way injure the card, provided the fire is hot enough.

Like everything else, a blue-print case must be taken care of in order to be efficient and serve its purpose. A little time spent now and then looking it over to see that all prints in use about the shop are checked and that all are in prime condition will prevent bother and waste of time sooner or later. It is good practice to have all prints collected from the various shops once a week and brought into the office case; this materially lessens the liability of their becoming lost.

N. C. HURST.

West Burlington, Iowa.

Yankee methods and British workmen are still performing feats that startle the British public, who have hardly had time to close their mouths from wondering at the records made in bricklaying at the British Westinghouse Co.'s works at Manchester when they are called upon to admire the huge chimney stack of the generating station of the Mersey Railroad Co. at Liverpool. Commenced about Christmas time, the stack, which is about 250 ft. in height, has been completed **already and stands as a record-breaker so far as expedition in building is concerned. The work has been carried out by the British Westinghouse Co., who have the contract for converting the Mersey railway tunnel from steam to electric traction, and the work has been done by British labor under the direction of Messrs. J. Stewart & Co., famous for record-breaking time in the construction of the Manchester works, the Galveston docks, and the renowned grain elevator "Kalumet K."**

The case which was brought against the Michigan Malleable Iron Company, of Detroit, Mich., in the United States District Court at Detroit by Canda Bros., New York, for alleged infringement of certain claims of their letters patent, No. 460426, has been decided by Judge Swan in favor of the defendant. The infringement charged was in the manufacture of draft apparatus by the Michigan Malleable Iron Company, under contract with the Thornburgh Coupler Attachments Company, Limited, of Detroit, the designs being covered by letters patent, No. 588722, granted William Thornburgh on August 24, 1897. The case was vigorously defended, and the victory gained fully sustains the validity of the Thornburgh patents.

The Traveling Engineers' Association will hold their tenth annual convention at Chicago, Ill., commencing September 9, 1902, at 9 A. M., with headquarters at the Stratford Hotel, corner of Jackson and Michigan Boulevards. Accommodations at the hotel, which is on the European plan, may be secured in advance, and also half-fare arrangements have been secured with the Pullman Company for members of the association and their families attending. It is announced also that the office of the secretary of the association, Mr. W. O. Thompson, will hereafter be at No. 7 Manning Square, Albany, N. Y., instead of at Elkhart, Ind., as formerly.

The total number of cars built in the United States in the year 1900, according to a recently issued bulletin of the Census Bureau, was 145,440. Of this number 118,504 were built by the contracting companies, the rest being built by the railroads. The cars were divided into classes as follows: Built by contract—Freight cars, 116,590; passenger cars, 979; street cars, 935; the railroads themselves built 26,543 freight cars and 390 passenger cars in their own shops.

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EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

THE LOCOMOTIVE—A THOUGHT FOR THE FUTURE.

The locomotive does not usually advance by radical changes; at least, the permanent improvements usually come very gradually, and result from careful study to meet special conditions. It is an interesting fact that in this country there have been comparatively few departures from perfectly simple construction, and advancement has followed the direction of increased size, weight and power. For five years this progress has been so rapid as to justify the criticism of rivalry in efforts to outdo previous weight and power.

Power is wanted, and the greatest success lies in securing the highest possible power and sustaining it for long pulls. This, however, has been sought in a way which has been characterized as "brutality and not engineering." The experience of the French railways in the development of the De Glehn engines suggests a possible line of improvement in this country, which appears attractive in view of the statements and opinions presented by M. de Glehn on another page of this issue (page 265). We have no counterpart of the French trains, considering the weight and speed which these engines pull, and it is doubtful whether our engines of equal weight and heating surface can equal their performances.

Additional complication is not desirable. A locomotive made all in one piece would be the natural finality of the present tendency here, but this is, of course, absurd; yet the fear of complication is equally absurd—the air-brake has proved that. Complication in a locomotive is, however, a question by itself, but M. de Glehn speaks plainly on this point from years of experience.

The adoption of French practice is not the object of this discussion. It is perfectly clear that we can learn much from French locomotive practice, and it is equally clear that the locomotive should soon have the benefit of the development in the matter of steam engineering which has led to such great improvements in marine and stationary engines. It would probably be an excellent investment for one of our American railroads to borrow one of the French four-cylinder engines and ascertain positively what it can do under our conditions. It is not adapted to them, but a practical experimental study of its design and construction would undoubtedly lead to an improved American locomotive with greater power per unit of weight than can be produced by our present methods. This, however, is but one of the possible advantages. The fundamental features of this French design, properly applied to our conditions and developed as our present designs have been developed, would produce power, capacity and economy of operation, which seem to be beyond the reach of our present methods.

Complication may, after all, be found to be a cheap price for greater capacity. This is worth finding out.

REHEATING COMPRESSED AIR.

It is generally understood that a saving results from reheating compressed air before its use in motors, but the figures presented elsewhere in this issue, page 271, by Messrs. Edmondson and Walker, indicate that the real importance of reheating is not appreciated. If it were, the principle would be more generally employed by the larger users of compressed air.

The experiments described show a maximum gain, by reheating, of 44 per cent. in the amount of air required to produce a given amount of power, and that a compressor which is able to supply 100 h.p. at the motors with cold air may be made to supply 178 h.p. by the use of reheaters. This means that many compressors, which are now overloaded and are running too fast, may be made more effective, and the day of replacement by larger machines put off, by installing reheaters. A reduction of 30 to 40 per cent. in cost of production of compressed air by reheating it from 60 to 400 deg. F. just before using is thoroughly worth while, especially when the simplicity of the reheating is considered.

The contractors constructing the new Rapid Transit Subway in New York, who are using compressed air very extensively, appreciate reheating and employ it very effectively. On one of the sections, where reheaters are used, the heaters are of cast iron, made all in one piece cored out, in the form of stoves with small grates for the fires. These are placed near the air drills and are left out of doors and unprotected. The expense of the fire and its attendance is insignificant in consideration of the great gain in power.

The above-mentioned paper is presented in a way to give the results at a glance to busy readers. The comparisons are presented in curves, in which not only the figures of comparison are given, but also the probable limits to the practical economy of reheating are indicated. The heater used was capable of producing much higher temperatures of air delivered, but about 450 deg. seemed to be the highest temperature for satisfactory use in the small engine employed. It is important to notice that the speed of the engine increased with reheating of the air; also that the engine ran more smoothly and the cut-off was shortened. That is to say, the increase of volume of the air is not by any means the only saving due to reheating. The action is somewhat similar to that of superheating for a steam engine. There is, of course, no freezing of the exhaust with reheated air.

Plants may be installed at reduced cost throughout and the economy of operation is increased permanently by using reheaters. This is most effectively stated by the authors when they point to the fact that the results obtained by applying

heat in this manner to compressed air are from 8 to 18 times more important than would be the same amount of heat expended under the boiler which drives the compressor.

The extent to which the draw-bar pull behind the engine may be carried during braking retardations due to lack of braking power on the engine's wheels was exhibited during the tests by B. J. Arnold in preparing his report concerning electric motive power on the New York Central. The following is quoted from his report:

"It appears that the braking effort per ton is not as high on certain types of locomotives as it is on coaches. This is due to the fact that not always are all the wheels of the locomotive braked, and those that are braked cannot be set to the skidding point with a fully loaded tender, for if they were they would then skid with a lightly loaded tender. Hence the draw-bar pull during retardation is often as great, or even greater, than it is during acceleration. An instance of this was noticed where the maximum draw-bar pull due to the braking effort of the train on the locomotive was 11,950 lbs., while the maximum draw-bar pull exerted in starting the train was 9,945 lbs. That is to say, in that particular run, during the period over which all possible retardation was desired, the draw-bar pull, instead of being zero, was 20 per cent. greater than that available for acceleration. In one record of a stop these figures became respectively 15,675 lbs., 9,899 lbs. and 60 per cent."

The facts thus revealed by the dynamometer car should call attention to this too easily overlooked matter of braking all wheels of locomotives.

The balanced locomotive in which there is not the least suspicion of the hammer blow upon the rail; the locomotive that, with four cranks set at the four quadrants of a circle, will give a non-racking, uniform rotative force approximating to the uniform rotative force of the electric motor, practically giving a higher coefficient of friction between wheel and rail, and giving that even pulling power which, in addition to the long cut-off of the compound, is going to handle the cars so much easier, not having to back an engine to take up the slack in a long freight train and then jerk it ahead to get it into motion, and incidentally jerk out a drawbar or two—this is the locomotive which is believed to be at the commencement of a new era in transportation in this country; a new era for the overworked rail, joint, tie and ballast, for the bridge, and for the locomotive repair shop.—Prof. H. Wade Hibbard on four-cylinder balanced compound locomotives, in a discussion on "Maximum Trains; Their Relation to Track, Motive Power and Traffic," before the New York Railroad Club, April 17, 1902.

It's a sign of inefficiency not to be able to get others to help us do our work. There are many men who cannot get others to take portions of their responsibilities. They cannot hand over the less important details in order that they themselves may devote more energy to the more important ones. A well-known and successful railroad officer has said that there is a limit to what one man can do, but no limit to what he can get others to do for him. "Blessed is that man who has found somebody to do his work." A man may furnish the inspiration for himself and others, but not often do we find a man who has the inspiration and is able alone to fulfill it in works.

The practice of using flanges on all driving wheels of locomotives is probably more general than most people think. It was recently stated before the Rocky Mountain Railway Club that since the year 1875 the Baldwin works alone have built 1,029 locomotives with flanges on all driving-wheel tires. Of these nearly 300 were of the consolidation type. These figures do not include the current year.

PERSONALS.

Mr. A. H. Thomas has resigned his position as mechanical engineer of the Chicago, Milwaukee & St. Paul Railway to accept a similar one on the Baltimore & Ohio.

Mr. S. K. Dickerson, division master mechanic of the Lake Shore & Michigan Southern at Cleveland, has recently been transferred to their new shops at Collinwood, Ohio.

Mr. R. S. Wickersham, formerly in charge of tonnage rating on the Santa Fe system at Topeka, has been appointed assistant engineer of tests of the Coast lines of the system, at San Bernardino, Cal., vice H. B. Gregg, resigned.

Mr. N. L. Rand has been appointed master mechanic, with office at Moncton, N. B., of the division of the Intercolonial Railway of Canada, extending from Moncton to Halifax and St. John, including the Moncton and Truro terminals.

Mr. R. Atkinson has resigned his position as superintendent of rolling stock of the Canadian Pacific Railway to become master mechanic of the Philadelphia & Reading, in charge of the new locomotive shops and roundhouses at Reading, Pa.

Mr. George W. Hepburn, of the Chesapeake & Ohio, has been promoted from his former position of assistant master mechanic of the Cincinnati division, at Covington, to that of master mechanic of the Kentucky division, at Lexington, Ky.

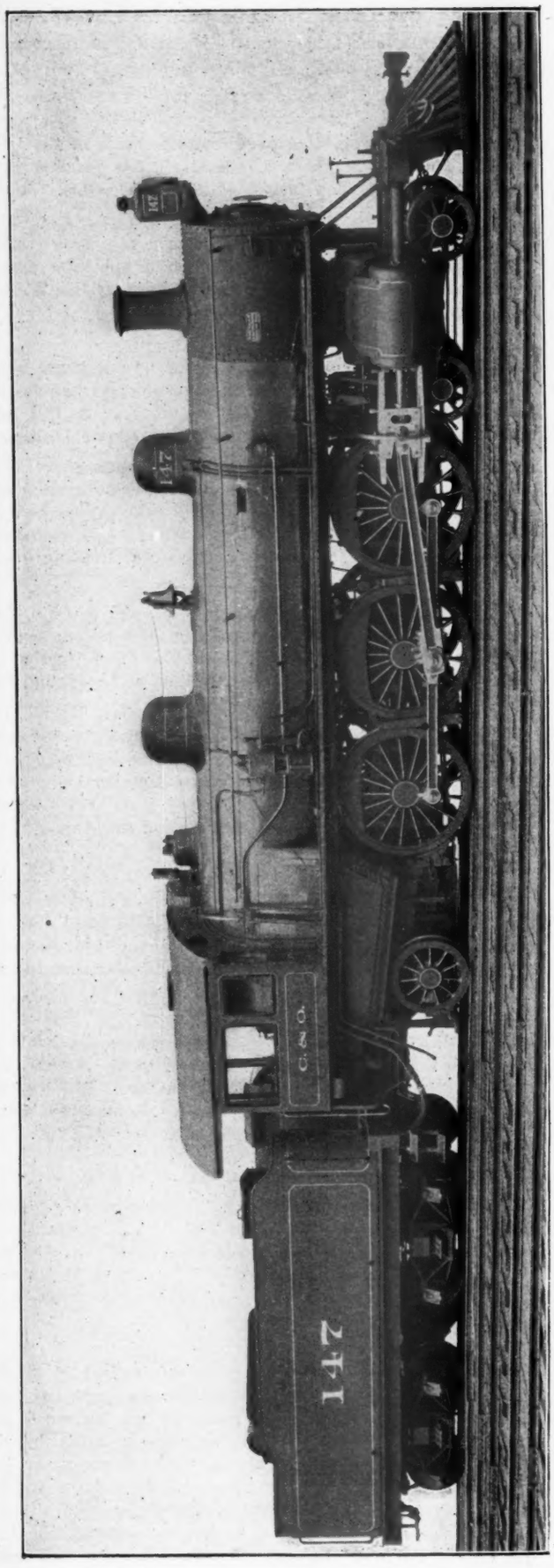
Mr. W. A. Nettleton has resigned his position of assistant superintendent of motive power of the Atchison, Topeka & Santa Fe, in order to devote his entire time to his private affairs. Mr. Nettleton was formerly for many years superintendent of motive power and machinery of the Kansas City, Fort Scott & Memphis Railroad.

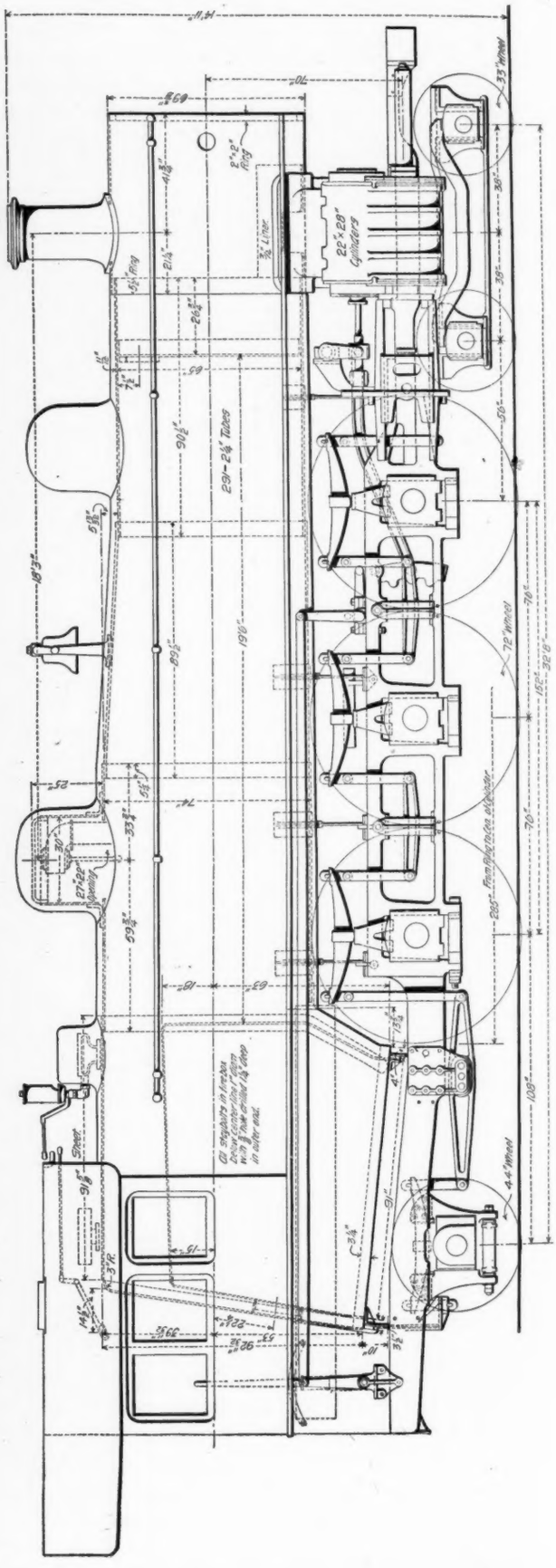
Mr. J. E. Simons has resigned his position as superintendent of rolling stock and machinery of the Pittsburgh Coal Company to accept the position of general manager of the Hunt Foundry and Machine Company, of Pittsburgh, which is a reorganization of the Hunt Air-Brake Company.

Mr. W. L. Kellogg has been appointed master mechanic of the Missouri Pacific at Fort Scott, Kan., to fill the vacancy made by the resignation of Mr. C. A. Sanders. Mr. Kellogg was formerly foreman of engines of the St. Louis, Iron Mountain & Southern at Little Rock, and previous to that traveling engineer on the C. St. P. M. & O.

Mr. A. E. Mitchell has resigned his position as assistant superintendent of motive power of the Chicago, Milwaukee & St. Paul to become superintendent of motive power of the Northern Pacific at St. Paul, Minn., succeeding Mr. Alfred Lovell. Mr. Mitchell was for many years superintendent of motive power on the Erie Railroad.

Mr. Fred Mertsheimer, formerly superintendent of motive power and machinery of the Kansas City Southern, has been appointed superintendent of machinery of the Denver & Rio Grande, at Denver, Col., to fill the vacancy made by the resignation of Mr. Henry Schlacks. Mr. Mertsheimer has been connected with both the Union Pacific and the Kansas City, Pittsburgh & Gulf Railroad in various mechanical capacities, having held the position of general superintendent of the latter road until three years ago, when he was made superintendent of motive power and machinery.





Six-Coupled Passenger Locomotive.—Chesapeake & Ohio Railway.

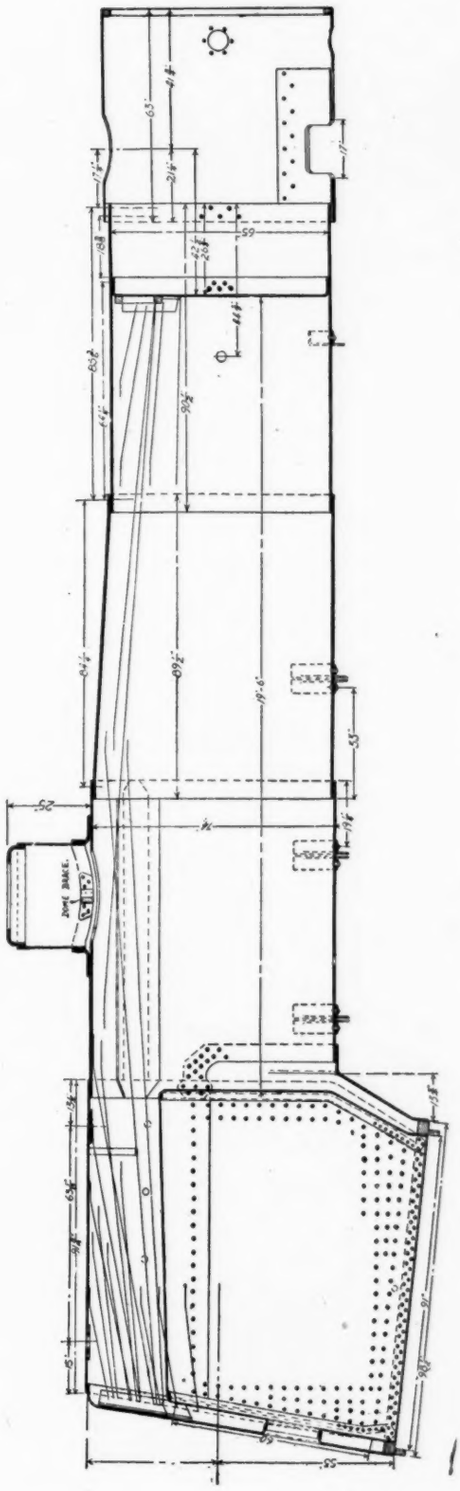
American Locomotive Company, Schenectady Works, *Builders.*

NEW SIX-COUPLED PASSENGER LOCOMOTIVES.

Chesapeake & Ohio Railway.

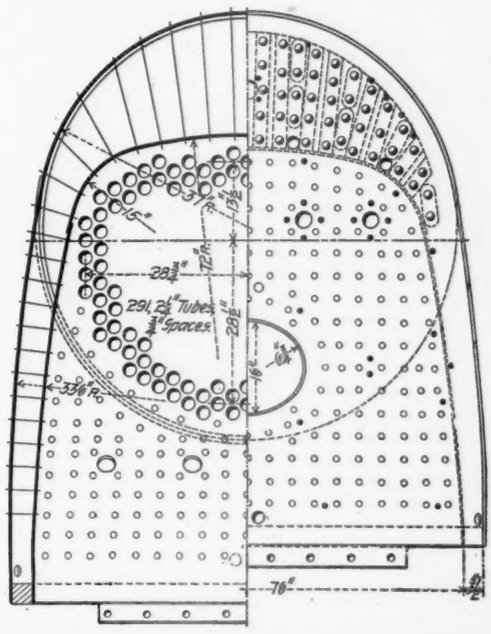
Missouri Pacific Railway.

In the August number, page 236, a description of two new passenger locomotives of the 4-6-2 type of wheel arrangement for the Chesapeake & Ohio and the Missouri Pacific Railways was begun. General plans are here given of these two engines in the accompanying engravings, and comparisons between the two may be made by aid of the drawings and additional information. There are but three passenger locomotives in the record issued with our June number heavier in total weight than the Chesapeake & Ohio engine, and but one, the Santa Fe Prairie type, with a larger heating surface. In length of flues, 19 ft. 6 ins., this engine leads the list. This length was undoubtedly due to the wheel arrangement and large driving wheels rather than to a desire to exceed previous practice in this particular. However, recent experience with 19-ft. tubes has thus far been satisfactory. These long tubes are 2¼ ins. in diameter. It is interesting to know that the opinion seems to be growing in favor of 2-in. tubes for these great lengths. The smaller tubes are believed to be more easily kept tight. With six-coupled passenger engines with large drivers and wide fireboxes the tube question is important and is worthy of intelligent investigation.



Longitudinal Section of Boiler.—C. & O. Locomotive.

These designs were both made by the American Locomotive Company, that of the Chesapeake & Ohio at the Schenectady,

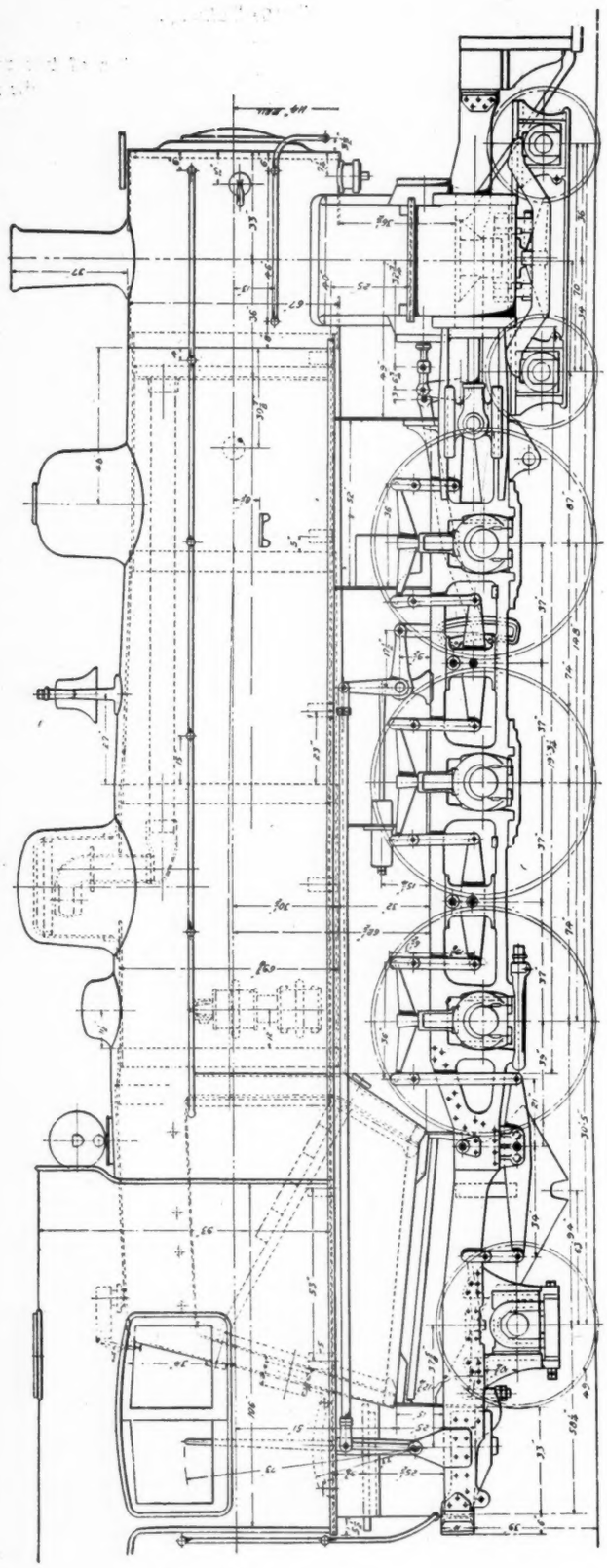


Cross Section Through Fire-Box.—C. & O. Locomotive.

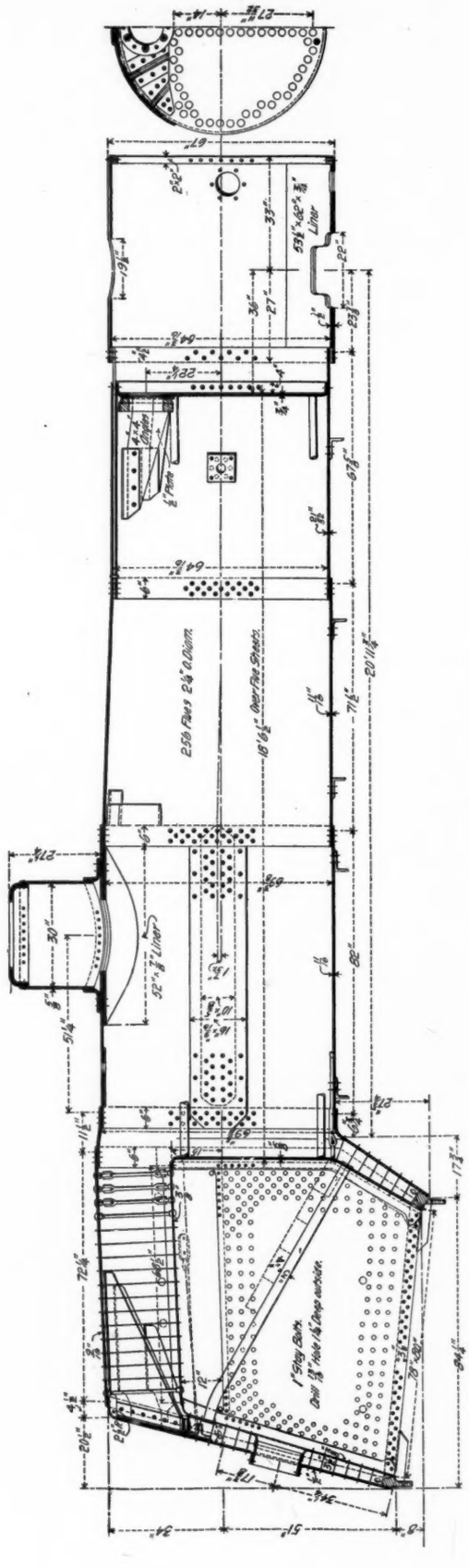
and the Missouri Pacific at the Brooks works. A few comparisons of ratios may be interesting:

	C. & O.	Mo. Pac.
Total weight to heating surface	52.9	58.6
Total weight to weight on drivers	1.427	1.441
Heating surface to grate area	75.1	70.2
Tractive power	32,000 lbs.	25,600 lbs.

Cast steel is used extensively in both designs. Both have inside admission piston valves with direct motion, the details being worked out differently, as appears in the engravings. The trailing trucks are entirely different, that of the Brooks design being Player's radial type, and that of the Schenectady a pedestal truck. The Brooks engine has cast steel hooks for the spring hangers and a novel cast steel, adjustable pedestal binder for the rear driving axle pedestals. This pedestal tie or binder, which is Mr. John Player's patent, is illustrated by



Side Elevation.

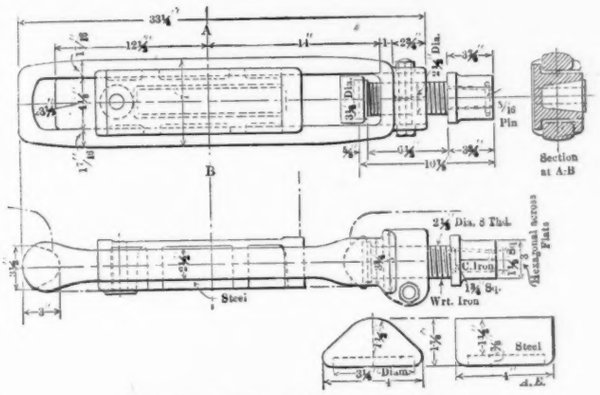


Longitudinal Section of Boiler.

Six-Coupled Passenger Locomotive.—Missouri Pacific Railway.

American Locomotive Company, Brooks Works, *Builders.*

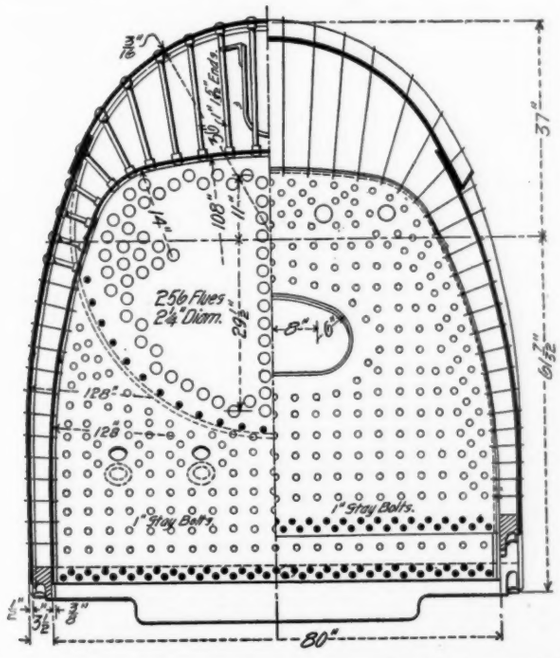
a drawing reproduced herewith, which clearly shows its construction. It is provided with a clamping screw at one end, the other portion of the binder being held and clamped together with bolts to prevent the screws from turning. The end of the binder screw is provided with a cast-iron protecting nut to prevent the corners from being worn off. The spacing block between the pedestal jaws is made of cast iron,



Cast Steel Adjustable Pedestal Binder. Missouri Pacific Locomotive.

and is provided with square wedge bolts. It may be noted that this spacing block is cored to secure extreme lightness. Tnis engine also has Player's new arrangement of the ash pan, with swinging doors hung on compensating links. The frames of both designs have single bar front sections and the fireboxes of both are supported on plates. Other features are made clear by the engravings.

The dimensions of the Missouri Pacific design were printed last month. Those of the Chesapeake & Ohio are as follows:



Cross Section Through Firebox.—Missouri Pacific Locomotives.

Heavy Six-Coupled Passenger Locomotive, 4-6-2 Type.
Chesapeake & Ohio Railway.
Description.

Gauge	4 ft. 9 ins.
Fuel	Bituminous coal
Weight in working order	187,000 lbs.
Weight on drivers	131,000 lbs.
Wheel base, driving	12 ft. 8 ins.
Wheel base, rigid	12 ft. 8 ins.
Wheel base, total, engine	32 ft. 8 ins.
Wheel base, total, engine and tender	60 ft. 0 ins.

Wheels and Journals.

Diameter of driving wheels outside of tire	72 ins.
Material of driving wheels, centers	Cast steel
Tire held by	Shrinkage
Driving box material	Cast steel
Diameter and length of main crank pin journals	7¼ ins. diameter x 4¾
Diameter and length of side rod crank pin journals	5 ins. diameter x 4½
Diameter and length of main side journals	7 ins. diameter x 6½
Diameter and length of driving journals	9 ins. diameter x 12
Engine truck, kind	4-wheel swing bolster
Engine truck, journals	6 ins. diameter x 12
Diameter of engine truck wheels	33 ins.
Kind of engine truck wheels	Steel tired

Cylinders.

Diameter of cylinders	22 ins.
Stroke of piston	28 ins.
Horizontal thickness of piston	5¼ ins.
Diameter of piston rod	3½ ins.
Kind of piston packing	Cast iron rings
Kind of piston rod packing	Metallic

Valves.

Kind of slide valves	Piston type
Greatest travel of slide valves	6 ins.
Outside lap of slide valves	1 in.
Inside clearance valves	⅛ in.
Lead of valves in full gear	Line and line
Kind of valve stem packing	Metallic

Boiler.

Style	Extended wagon top, wide firebox
Outside diameter of first ring	66 ins.
Working pressure	200 lbs.
Material of barrel and outside of firebox	Steel
Thickness of plates in barrel and outside of firebox,	11-16 in., ¾ in., ½ in., 23-32 in.
Firebox, length	90 ins.
Firebox, width	75 ins.
Firebox, plates, thickness,	Sides ⅜ in., back ⅜ in., crown ⅜ in., tube sheet ½ in.
Firebox, water space,	Front 4 and 5 ins., sides 3½ and 5½ ins., back 3½ and 4½ ins.
Firebox, crown staying	Radial stays
Firebox, staybolts	Iron
Tubes, material	Charcoal iron No. 12
Tubes, number of	291
Tubes, diameter	2¼ ins.
Tubes, length over tube sheets	19 ft. 6 ins.
Fire brick, supported on	Water tubes
Heating surface, tubes	3,328.28 sq. ft.
Heating surface, water tubes	23. sq. ft.
Heating surface, firebox	182. sq. ft.
Heating surface, total	3,533.28 sq. ft.
Grate surface	47.02 sq. ft.
Exhaust pipes	Single high
Exhaust nozzles	5¼ ins., 5½ ins. and 5¾ ins. diameter
Smokestack, inside diameter	18 ins.
Smokestack, top above rail	14 ft. 11 ins.

Tender.

Wheels, number of	8
Wheels, diameter	36 ins.
Journals, diameter and length	5 ins. diameter x 9 ins.
Wheel base	16 ft. 8 ins.
Tender frame	10-in. steel channels
Tender trucks,	Schenectady Works standard with C. & O. box and center plate
Water capacity	6,000 U. S. gallons
Coal capacity	8 (2,000 lbs.) tons

Petroleum briquettes are being successfully introduced in France. These briquettes are composed mainly of petroleum, crude or refined, and they possess all the advantages of coal and of oil, without the inconveniences of either. They weigh half as much as coal, and leave only 2 or 3 per cent. of residue. They do not melt or run. When stored do not absorb moisture and will keep indefinitely. They will not explode, and are not liable to spontaneous combustion. The method of manufacture is simple; petroleum is placed in one tank and the necessary chemicals in another. Both are allowed to flow into a mixing apparatus, where chemical combination takes place. The product is then pressed to the desired shape, and is ready for use. As this mode of procedure is simple, the plant necessary is very inexpensive. The use of this chemical combination as binder and enricher solves the difficulty encountered in making coal dust or sawdust briquettes. The relative advantage of coal and briquettes may be stated thus: If a boat takes 2,000 tons of coal to steam a certain number of miles, it would require only 1,000 tons of petroleum briquettes to cover the same distance, and steam would have been raised in much less time. These briquettes can be used for any kind of domestic or industrial work. They burn with a very white flame, without smell or smoke, and are convenient and easy to handle. The briquettes are likely to be adopted by the French government, as a cheap and efficient fuel. It is estimated that they would cost about $1.54 for 220 lbs., or, in other words, $14 per ton of 2,000 lbs.

TRACTIVE-POWER FORMULAE.

By George F. Summers, M. E.

It is evident that a simple tractive-power formula will not exactly fit any two engines, for every locomotive has its peculiarities, and not only does each builder have his own ideas about the design, but the general engineering practice is changing from year to year. Where possible, it would seem best to take indicator cards from each class of engines from which to figure the hauling capacity of similar locomotives; and it is for the purpose of basing one engine upon experience with another that the following approximate formulæ are arranged.

The symbols used in this discussion are:

T = the maximum indicated tractive power. That is, the force or pull of a locomotive, at slow speed, on a straight, level track, including the force necessary to overcome the friction of the moving parts as well as that necessary to propel the engine, tender and train. To take out of the tractive power the effect of the internal friction, multiply T by 92 per cent. This figure is taken from Mr. G. R. Henderson's paper on page 205, Master Mechanics' proceedings, 1901. The force to propel the locomotive and tender may be found from tables or other sources, and is not taken up in this article. The remainder is the force at the tender coupler available to pull a train.

C = diameter in inches of low-pressure cylinder.

c = diameter in inches of high-pressure cylinder, or in simple engines of either cylinder.

s = stroke in inches.

D = diameter in inches of driving wheels when new.

H = equals pressure in pounds on piston of low-pressure cylinder, and is equal to the product of the difference between the cylinder area and the average piston-rod area, multiplied by the mean effective pressure for the low-pressure cylinder.

h = pressure in pounds on piston of high-pressure cylinder, or in simple engines of either cylinder.

b = boiler-working pressure in pounds per square inch.

k = the percentage to multiply into the boiler pressure to obtain the mean effective pressure in simple engines, or the sum of one high mean effective pressure and one low mean effective pressure in compound engines.

M = mean effective pressure in pounds per square inch in low-pressure cylinder.

m = mean effective pressure in pounds per square inch in high-pressure cylinder, or in simple engines the mean effective pressure of either cylinder.

For simple engines:

$$T = \frac{kbc^2s}{D};\ k = \frac{1.27324\ h}{c^2b};\ \ldots\ldots\ldots\ldots(1)$$

log. 1.27324 = .104910, if T is based on card Fig. 1; k = .85905, log. k = — 1.934020.

For two-cylinder compound engines with receiver:

$$T = \frac{kbc^2C^2s}{(c^2 + C^2)\ D};\ k = \frac{1.27324\ h\ (c^2 + C^2)}{bc^2C^2};\ \ldots\ldots(2)$$

If T is based on card Fig. 2; k = .87914, log. k = — 1.944057.

For four-cylinder compound engines without receiver:

$$T = \frac{kbc^2C^2s\left(\frac{1}{\frac{h}{H}C^2 + c^2} + \frac{1}{\frac{H}{h}c^2 + C^2}\right)}{D};\ \ldots\ldots\ldots(3)$$

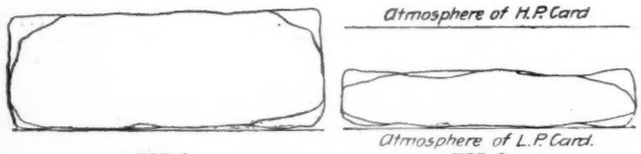


FIG. 1.

Simple engine.
C. & N. W. eng. No. 1017.
20 x 26-in. cyl.; 80-in. drivers; 3¼-in. piston rod not extended.
Boiler pressure, 163.
19 miles per hour.
m. e. p., 141.9.

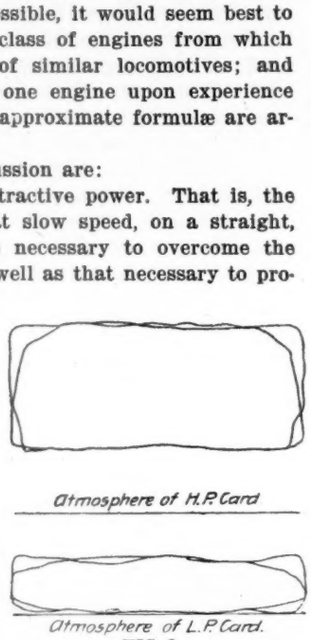


FIG. 2.

2-cylinder compound engine working compound.
Northern Pacific engine No. 170.
22-in. and 34 x 26-in. cyls.; 63-in. drivers; 3¾-in. rods, with 2¾-in. extensions.
Boiler pressure, 204.
10.8 miles per hour.
m. e. p.: h. p. cyl. = 129.13; l. p. cyl., = 53.5.

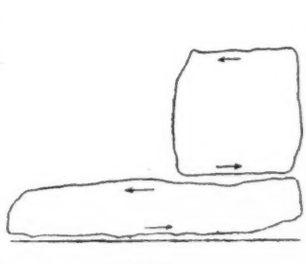


FIG. 2a.

The same card as Fig. 2, the lengths being reduced to the ratio of the cylinder volumes. The areas of this diagram are proportional to the work done in the cylinders.

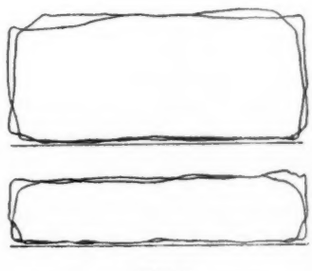


FIG. 3.

2-cylinder compound engine working simple.
Northern Pacific engine.
23-in. and 3 x 30-in. cylinders; 55-in. drivers.
Boiler pressure, 200.
3.3 miles per hour.
m. e. p.: h. p. cyl. = 128.88; l. p. cyl. = 69.0.

Tractive Power Formulae.

$$k = \frac{1.27324\ (h + H)}{bc^2C^2\left(\frac{1}{\frac{h}{H}C^2 + c^2} + \frac{1}{\frac{H}{h}c^2 + C^2}\right)};\ \ldots\ldots(3)$$

If T is based on card Fig. 3;

$$k = .87323,\ \text{log. } k = -1.941131$$
$$\frac{h}{H} = .75172,\ \text{log. } \frac{h}{H} = -1.876057$$
$$\frac{H}{h} = 1.3303,\ \text{log. } \frac{H}{h} = .123943$$

For two-cylinder compound engines working simple; consider them as simple engines, with both cylinders the size of the high-pressure cylinder.

For four-cylinder compound engines working simple; consider them as two simple engines, each with two cylinders the size of the high-pressure cylinders.

The formula for simple engines is computed as follows: In equation (3)

make H = h,
and C = c,
then $T = \frac{kbc^2s}{D}$, the required formula.

The formula for two-cylinder engines is computed as follows:

For simplicity it is assumed that the work done in the high-

pressure cylinder is equal to that done in the low-pressure cylinder.

Then in equation (3)

$H = h$; and observing that there are two cylinders instead of four,

$$T = \frac{kbc^2C^2s}{D\ (c^2 + C^2)}, \text{ the required formula.}$$

The formula for four-cylinder engines is computed as follows:

For simplicity it is assumed that the sum of the mean effective pressures is proportional to the boiler pressure, $M + m = kb$, and that the proportion of work done in each cylinder is the same as in the base engine.

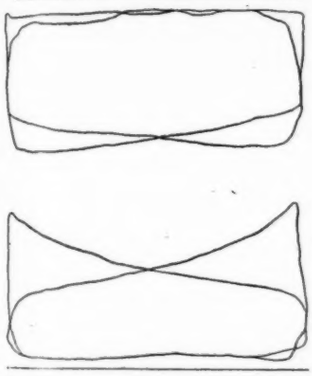


FIG. 4.

Tandem compound engine working compound.
H. p. spring, 100; l. p. spring, 50.
Northern Pacific eng. No. 17.
15-in. and 28 x 34-in. cyl.; 55-in. drivers; 3¾-in. and 3-in. rod not extended.
Boiler pressure, 205.
5.9 miles per hour.
m. e. p.: h. p., 132.2; l. p., 50.2.

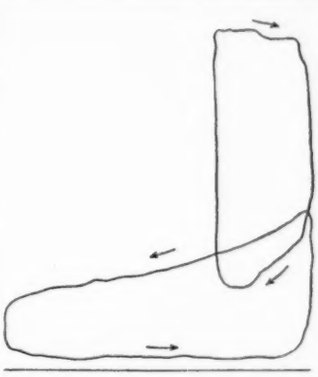


FIG. 4a.

The same card as Fig. 4, the lengths being reduced to the ratio of the cylinder volumes.

$$\frac{m\ c^2}{M\ C^2} = \frac{h}{H},\ m = \frac{MC^2h}{c^2H},\ M + \frac{MC^2h}{c^2H} = kb,$$

$$M = \frac{kbc^2}{\frac{h}{H}C^2 + c^2},\quad m = \frac{kbC^2}{\frac{H}{h}c^2 + C^2}$$

work = force multiplied by distance, therefore force = work divided by distance.

$$\text{Tractive force} = \frac{\text{work done in cylinders}}{\text{distance traveled by engine}}.$$

For one revolution

$$T = \frac{2 \times m \times c^2 \times \frac{\pi}{4} \times 2 \times s + 2 \times M \times C^2 \times \frac{\pi}{4} \times 2 \times s}{\pi D}$$

$$kbc^2C^2s\left(\frac{1}{\frac{h}{H}C^2 + c^2} + \frac{1}{\frac{H}{h}c^2 + C^2}\right) = \frac{}{D}, \text{ the required formula.}$$

"The White Mountains as Viewed From the Summit of Mt. Washington" is the title of an interesting map recently issued by the Boston & Maine Railroad to instruct its patrons concerning the topography of New England. It is finished in several different colors, with a printed list showing the names of each mountain peak, as well as also the numerous ravines and valleys. This map is an instructive work and is something entirely original. It will be mailed to any address by the general passenger department of the Boston & Maine Railroad, Boston, Mass., upon receipt of 6 cents in stamps.

BOOKS.

"Logarithmic Tables of the Measures of Length." Logarithms of lengths, from 0 to 50 feet, advancing by intervals of one-sixteenth of an inch. By Thomas W. Marshall. Published by The Engineering News Publishing Company, New York, 1902. Price, $2.

These tables are apparently intended for the use of draftsmen and computers in structural work mainly. The book is well arranged and of good typography. The two pages open at any place cover one entire foot, the logarithms being given for every sixteenth of an inch. The book is bound in leather, in pocketbook form, and has an introduction clearly explaining the use of the tables.

"Handbook for Street Railway Engineers." A book of tables and formulæ covering the principal electrical and mechanical problems to be met in street railway work. By H. B. Andrews, C. E., Boston, Mass. Bound in morocco, size 3 x 5 ins., 202 pages and 41 figures. Published by John Wiley & Sons, 43 East Nineteenth street, New York, 1902. Price, $1.25.

This little work is intended to present in very compact form the tables and formulæ needed for the problems most likely to be met in practice by street railway engineers. The author, during his long connection with the Boston Elevated Railway Company, has computed and tabulated much of the information given, and the remainder has been compiled from various reliable sources. Information regarding the following subjects, and others, is furnished: Mensuration, trigonometrical formulæ, circular curves, compound transition curves, plain curves, bending moments, strength of materials, data for estimates, aluminum for electrical conductors, the storage battery, relative percentages of expenditures to gross receipts for street railways in Massachusetts. We can recommend this work to those desirous of having at hand a collection of information that will be of the most practical value in every-day work.

American Standard Specifications for Steel. By A. L. Colby, South Bethlehem, Pa. Price $1.10.

Mr. Colby's admirable little book opens with a short introduction in which he briefly traces the history and objects of the movement to standardize specifications for steel. He says that, at first, though these specifications, drawn up by the Association of American Steel Manufacturers, were regarded somewhat by the technical press as "manufacturer's standards," they nevertheless steadily grew in favor among consumers. The work in the main consists of a critical review of these specifications, and the author sets forth the reasons which influenced the committee in reaching its various conclusions. Mr. Colby took an active part in the work of standardization and knows his subject thoroughly. Restrictions as to the details of the manufacture were excluded, because the committee held it to be generally outside the province of the engineer to specify details of metallurgical processes, when afforded facilities for fully testing the finished product. That is practically what many of our railroad cast-iron car wheel makers are saying to superintendents of motive power. In an appendix are given nine standard specifications, which include steel castings, axles, forgings, tires, rails, splice bars, structural steel for buildings, structural steel for bridges and ships, and open hearth boiler plate and rivet steel.

"Theory of Steel Concrete Arches, and of Vaulted Structures," William Cain, M. Am. Soc. C. E. Second edition. Thoroughly revised. Van Nostrand Science Series, No. 42; pp. 182. Price, 50 cents.

In this volume Prof. Cain describes a graphical method for examining the strength of the following structures, viz.: Arches of variable section under vertical loads, culverts and tunnel arches, groined and cloistered arches, and domes of masonry. In particular he discusses thoroughly the method of investigating a concrete-steel arch. Eddy's graphical treatment is followed. The theory of the action of concrete-steel which Prof. Cain uses is not new, but is based on the idea proposed by Prof. Johnson and others, of considering the re-enforcement replaced by an equivalent area of concrete. The usual arch formula is then applied to the graphical results to find the maximum stresses normal to the assumed sections. Prof. Cain also proves that the temperature stresses in a concrete-steel arch are not negligible, as many engineers contend. The book will be very useful to the draughtsman or architect who needs a compact method to determine the stresses in such arched structures, whether of concrete-steel or masonry. The style is clear, the directions are explicit. To the trained engineer it presents nothing new, but may prove valuable for reference.

NEW AIR-BRAKE INSTRUCTION CAR.

New York Central & Hudson River Railroad.

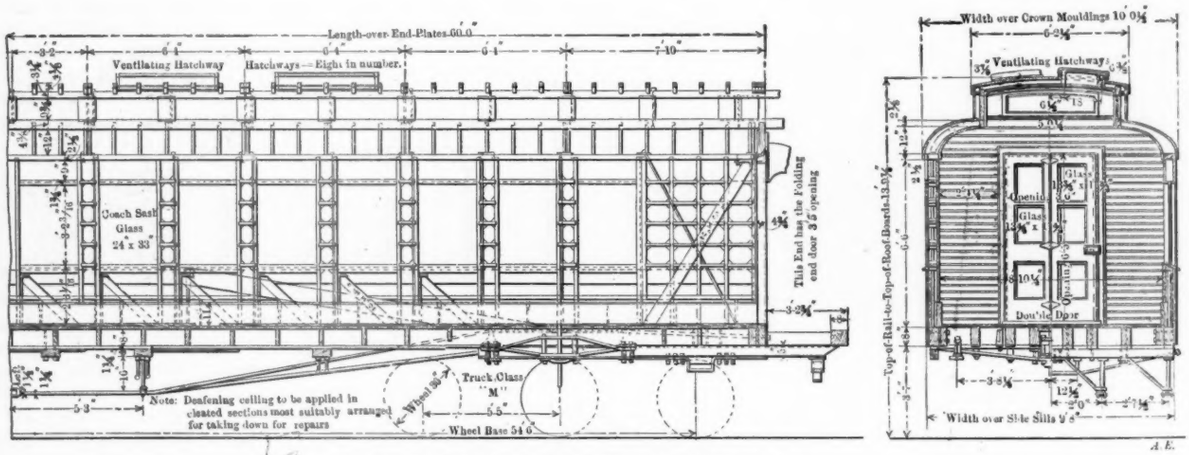
A new air-brake instruction car, involving some interesting new features, has recently been placed in commission by the New York Central. A novel method of ventilation has been introduced on this car for use while classes are in progress, and also a new departure has been made in the method of driving the air-compressor.

The construction of the car is clearly shown in the accompanying side and end sectional elevation views, which also indicate the general dimensions. The method of ventilation mentioned consists of a series of eight ventilating hatchways arranged in pairs along the roof of the car, as shown, which may be opened up during classes. These hatchways give openings of 4 ft. 1⅛ ins. long by 1 ft. 6 ins. wide, and are arranged with hinged covers which may be locked shut or open. The hatchway-covers, as well as the roof, are covered with heavy duck canvas embedded in white lead.

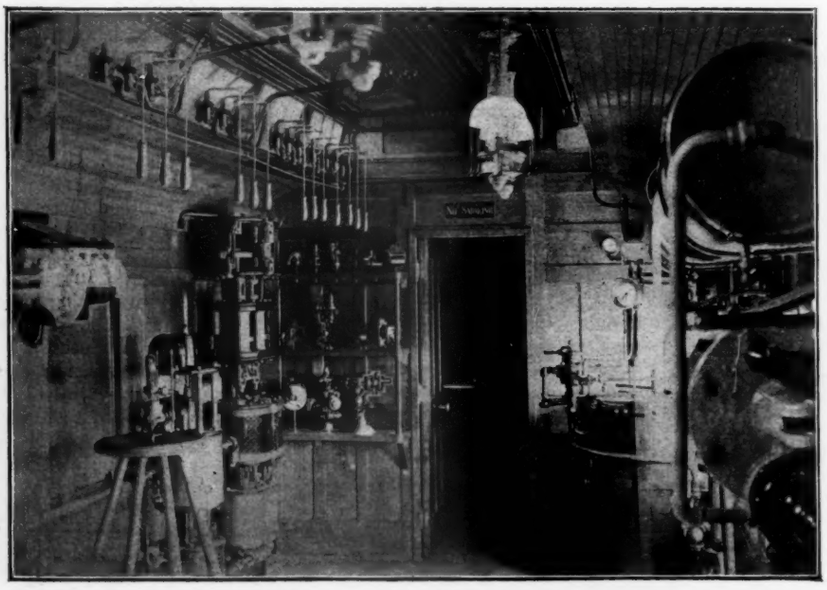
Another convenient improvement in the construction of this car is the double door in the forward end, as shown in the end elevation views. The two doors are hinged together at the middle, and, in opening, double back upon each other, giving thus a total opening of 3 ft. 6 ins. by 6 ft. 5 ins. The flooring of the car is double, consisting of an upper floor 1⅛ ins. thick and a ⅞-in. floor beneath, laid at an angle of 45 degrees.

The car is divided off into three compartments, one at each end and a large one at the middle. The large central compartment, which is 31 ft. long, is devoted to the air-brake instruction equipment, air signal apparatus, models, etc. The forward compartment contains the air-compressor, a work-bench, etc., while the compartment at the opposite end of the car (not shown) contains an office and sleeping compartments for the officials in charge of the car. A desk 24 by 48 ins. is provided, together with a book-case, chairs, etc., on one side, and on the other is a standard upper and lower berth and a closet containing a clothes-press and washbasin.

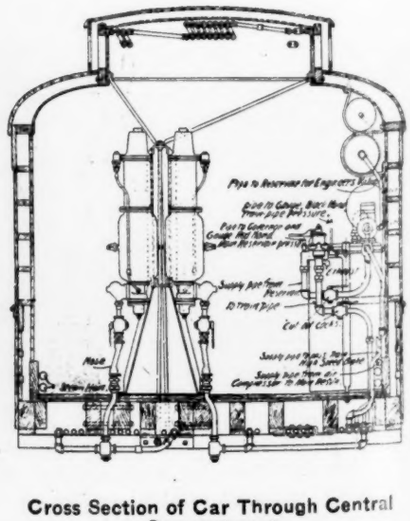
The instruction compartment is provided with a 20-car-train air-brake equipment, the brake cylinders being arranged as shown in the floor plan of the car. The 20 brake cylinders are supported in a framework, which is thoroughly braced, as shown in the elevation views. The various air-brake devices usually carried on locomotives and tenders are secured to the left side of the car at the rear of the central portion. The


Length over End Plates 60.0
Ventilating Hatchway
Hatchways—Eight in number.
Coach Sash Glass 24" x 33"
This End has the Folding end door 3'6" opening
Truck Class "M"
Wheel Base 5'6"
Note: Deafening ceiling to be applied in cleated sections most suitably arranged for taking down for repairs
Width over Crown Mouldings 10' 0½"
Ventilating Hatchway
Double Door
Width over Side Sills 9' 6"

Part Side and End Elevation View of Car.



Interior View of Car Looking Toward Office.



Cross Section of Car Through Central Compartment.

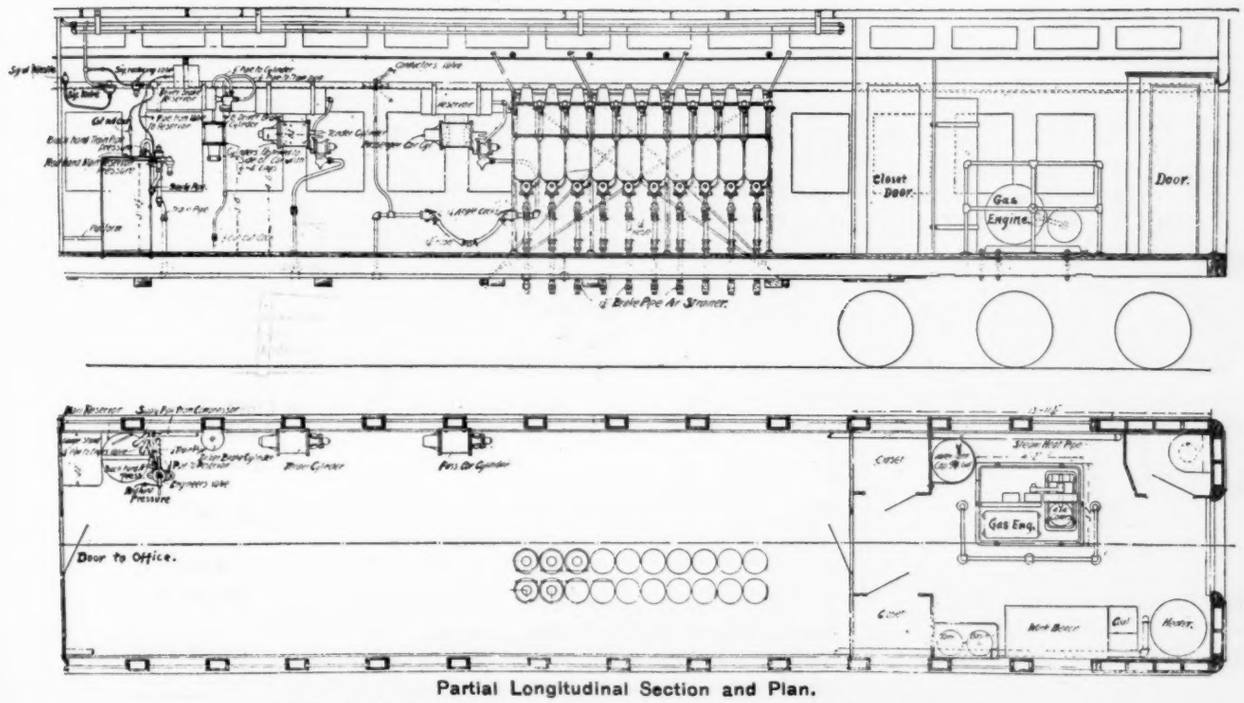
New Air Brake Instruction Car.—New York Central & Hudson River Railroad.

bank of train-line piping is carried under the frame of the car and tightly clamped to the sills to prevent rattling, the cut-out cocks being operated by a key through openings in the floor over the valve stems.

The air signal instruction apparatus consists of a 15-car-train equipment, together with the requisite signal-train-line piping, for illustrating the different handling necessary in signaling from the rear end of a long passenger train as compared with that at the front end. A portion of the signal train-line—the first nine cars—is run along the lower side of the deck between the ventilating hatchways and the remainder is placed outside above the deck windows, as is clearly shown in the interior view of the car. This interior view also shows the location of the signal discharge valves on the right-hand side of the car, as well as the location of the engineer's air-brake valve above the main reservoir at the left side, and the triple valve, governor, brake-cylinder and pump sectional models in the corner opposite.

A very commendable innovation has been introduced in the method of driving the air-compressor by a gasoline engine, which not only frees the car from the heat, dust and other unpleasant features of the steam boiler, but also renders unnecessary the services of an attendant for the boiler. The gas engine-compressor set is situated in the forward compartment, toward the middle of the floor, for ease of access to all portions of the engine and compressor. The compressor, which is belt-driven from the gasoline engine, has a capacity equal to an 8-in. Westinghouse pump. Cooling water for the cylinder jacket of the engine is supplied from the 98-gallon tank adjacent, and the compressor set is surrounded by a pipe guard-frame. The compressor is 6 by 6 in. and the engine 5 h p.

This is probably the first use of a gasoline engine for driving an air-compressor in such service as this; but why is this not an ideal motive power for such work? It is true that gas engines give trouble when not adjusted properly with respect to the proportion of air and gasoline in the explosive mixture, to the time of the ignition, etc., but the many advantages of cleanliness and independence of operation are too great to be overlooked. An incidental result, also, from the use of the gasoline engine for such purposes is that a licensed engineer will not be required in attendance in cities having boiler-inspection laws, as with the boiler and steam compressor.



Partial Longitudinal Section and Plan.

Air Brake Instruction Car.—New York Central & Hudson River Railroad.

NEWEST TYPE OF SCHMIDT SUPERHEATED STEAM MOTOR.

After many experiments, Mr. J. E. Christoph, Niesky, Lausitz, has succeeded in successfully constructing a Schmidt motor with a double-acting high-pressure cylinder. The engine is tandem compound; diameters of cylinders, 12 and 19½ ins., respectively; stroke, 28 ins.; revolutions per minute, 120. The boiler pressure is ten atmospheres, and the steam is superheated to a temperature of 350 degrees C. The engine is fitted with an apparatus which allows an admission of highly superheated steam for 20 per cent. of the stroke; as soon as the admission becomes greater than 20 per cent., a regulator opens a second valve, which admits saturated steam. The quantity of saturated steam admitted is greater according as the admission period becomes greater, this arrangement allowing the superheated steam motor to be made double acting.

The engine is installed at the paper works of Mr. F. Erfurt, Straupitz, and an engine economy of 11¼ lbs. of steam per horse-power hour was guaranteed by the maker. Two trials, each lasting eight hours, were carried out. In the principal trial the engine developed 147.75 indicated horse power, the steam consumption was 10.2 lbs. per indicated horse-power hour, and the boiler efficiency was 54 per cent. The temperature of saturated steam corresponding to the pressure was 183 degrees C., the temperature of the steam as it left the superheater was 402 degrees, temperature at admission to the high-pressure cylinder, 339 degrees. The temperature of the gases on the way to the superheater was 615 degrees, after leaving the superheater and economizer it was 176 degrees, while the temperature in the chimney was 131 degrees.

The apparently low boiler efficiency is attributed to the probable leakage of coal air to the flues through the brickwork. —Foreign Abstracts, Institution of Civil Engineers.

GRAPHICAL METHOD OF FINDING LIMIT DIAMETERS FOR CAR AND TENDER AXLES.

R. B. Kendig, Chief Draughtsman, L. S. & M. S. Ry.

The method of analysis devised by an M. C. B. Association Committee of 1896, for arriving at the limit diameter of, or the safe working load which may be applied to, car or tender axles in connection with the design of an axle for an 80,000-lb. capacity car, is conclusive enough to be looked upon as authoritative. Equation 10 of this committee's report, page 152, M. C. B. Proceedings, 1896, for finding the bending moment at any point on the axle between the wheels, can be simplified considerably, as will be shown, without detracting from its accuracy when applied to the usual conditions of practice.

For convenient reference formula 10 is quoted:

$$\text{"Bending moment, } M = \frac{Wb}{2} - \frac{Hh}{m}(X - b) + \frac{Hh_1x}{L} + Hh_2 + \left(\frac{W}{2} - \frac{Hh}{m}\right) h_2 \tan a,"$$

in which

W = The total vertical pressure on the axle, including allowance of 26 per cent additional for vertical oscillation;
H = The horizontal force caused by curves, switches and wind pressure;
h = Height of center of gravity of car above top of rail;
h_1 = Height of center of gravity of car above center of axle;
h_2 = Height of center of axle above top of rail;
L = Length of axle between points where load is assumed applied;
m = Distance between centers of rails;
b = Distance from center of rail to point where load is assumed to act;
a = Angle that wheel tread makes with horizontal, and
x = Any distance between hubs measured from point where load is assumed applied, to point where bending moment is required.

When we consider the application of this formula in connection with the combination of a standard gauge track, 33-inch wheels and a car having its center of gravity with load six feet above the rail, we have left but three variables, viz.: W, L and X; for we can assume H = .4 W; h = 72 inches; h_1 = 55.5 inches; h_2 = 16.5 inches; m = 59 inches; b = ½ (L — M); tan a = .026. We can now substitute this new value for "b" in the terms in which it is given, and write:

$\frac{WL - Wm}{4}$ instead of $\frac{Wb}{2}$, and

$\frac{2\,Hhx - HhL + Hhm}{2m}$ instead of

$\frac{Hh}{m}(x - b)$;

then by giving numerical values to the symbols representing the quantities assumed as above, we have:

$$M = .25WL - 14.75W - .4881\,WX - 14.4W + .2441\,WL + \frac{22.2\,WX}{L} + 6.6W + .005166W; \quad \ldots\ldots (1)$$

reducing:

$$M = .4941\,WL + \frac{22.27X}{L} - .4881\,WX - 22.545\,W; \quad \ldots\ldots (2)$$

and further, including 26 per cent. for vertical oscillation:

$$M = W\left(.6226L + \frac{27.97X}{L} - .615X - 28.41\right) \quad \ldots\ldots (3)$$

The bending moment at the center of the axle, "X," becomes .5 L; then we have:

$$M = .3151\,WL - 14.425\,W \quad \ldots\ldots (4)$$

Now, if we assume the hub located the same as with the M. C. B. wheel; that is, 48½ inches face to face of hub, X becomes $\frac{L - 48.5}{2}$ and the moment at the wheel seat becomes:

$$M = .3151\,WL + .489\,W - \frac{678.27W}{L} \quad \ldots\ldots (5)$$

Equations (4) and (5) have been substituted for M in the formula, $d = \sqrt[3]{\frac{M}{.0982f}}$, in which "d" is the diameter and "f" the fibre stress per square inch, the latter being taken at 22,000 lbs., and the results plotted as shown in the accompanying diagram, showing diameter curves for values of W ranging from 10,000 to 45,000 lbs., and values of L ranging from 76 inches to 80 inches, inclusive. In the same manner the bending moment for the journal is substituted in the equation for diameter, the fibre stress being assumed at 10,000 lbs. per square inch. The bending moment is here simply M = .5WJ,

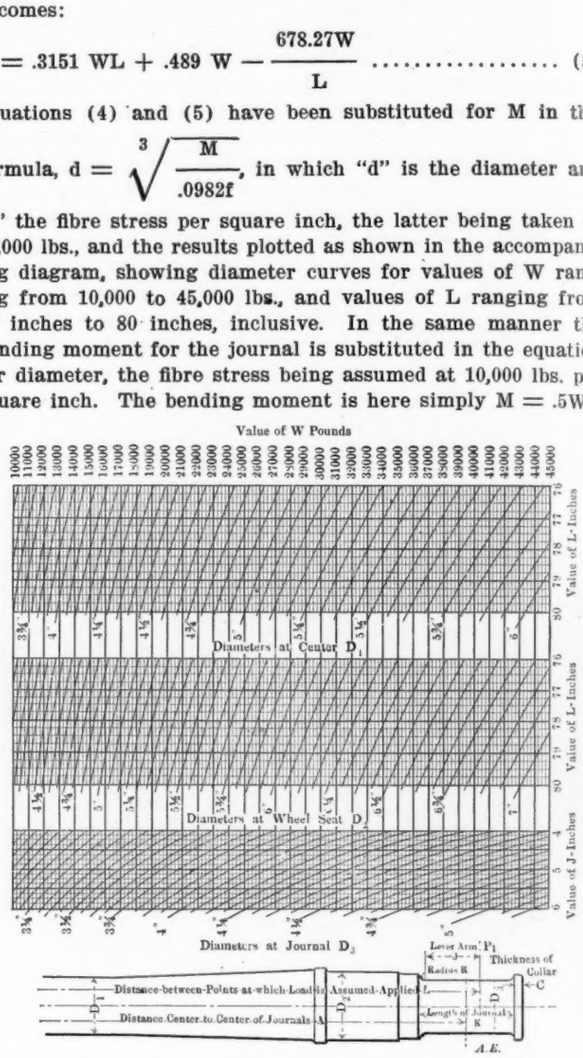


Diagram for Determination of Limit Diameters of Car and Tender Axles.

NOTE—This diagram was accidentally made too small. It will be reproduced in our next number.—EDITORS.

and results are plotted for a range between 4 inches and 6 inches for J.

The factor, L, is found in the manner described by Mr. E. D. Nelson, in a communication to the M. C. B. Association in 1901, viz.:

$$L = A + 2C + R + \tfrac{1}{2}\text{ inch};$$

$$\text{and also } J = \frac{L + K - A - 2R}{2}.$$

The horizontal lines at the upper part of the diagram represent values of "L," and those in the lower group values of "J;" the vertical lines represent the total load, "W," on one axle, and the groups of curved lines represent the diameters at center D_1, at wheel seat D_2, and at journal D_3, respectively, for corresponding values of W and L, and W and J.

As a convenient example showing the application of the diagram, let us take the M. C. B. 5 x 9 inch axle, in which A = 76 inches, C = ¾ inches, R = ¾ inches, and K = 9 inches; then L = 76 + 1½ + ¾ + ½ = 78¾ inches, and $J = \frac{78¾ + 9 - 76 - 1½}{2} = 5⅛$ inches.

Now, with given axle load of 32,000 lbs., let it be required the proper diameters for the axle: For the diameter at Center D_1,

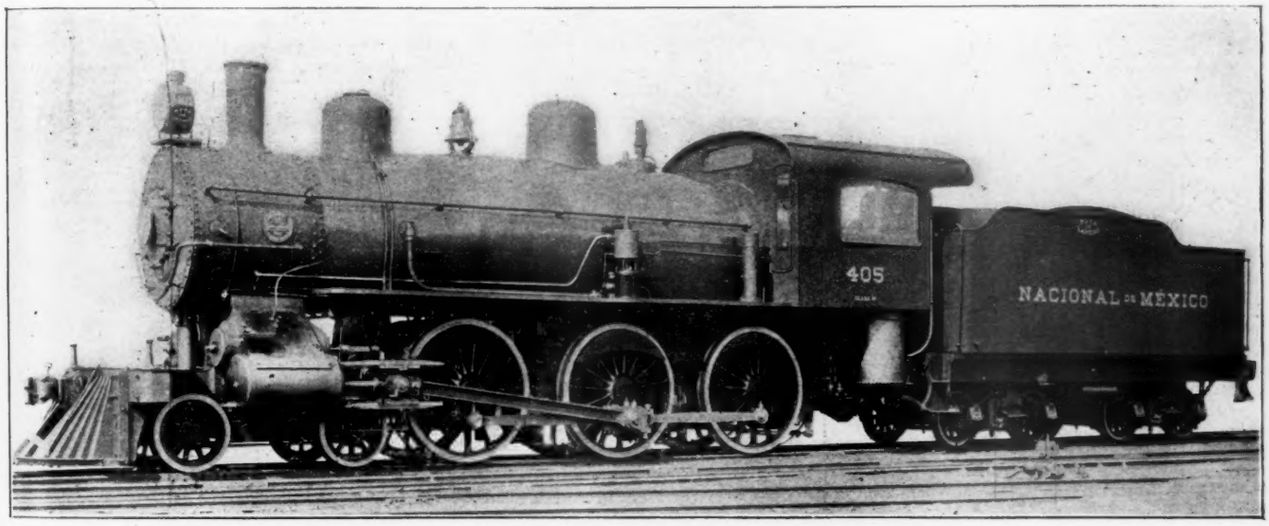
follow down the horizontal line representing value of L = 78¾ inches to the vertical line representing the value of W = 32,000 lbs., and the curve, 5⅜ inches, next above their intersection, is the required diameter. In the same manner D_2, the diameter at the wheel seat, is found to be 6 5-16 inches, and by following down the horizontal line representing the value of J = 5⅛ inches to the vertical line representing 32,000 lbs., we find the diameter at journal to be 4⅜ inches. The curves are plotted by increments of 1-16 inch, but values may be interpolated closer if desired, as those selected in this way will not vary by more than .02 inch either way from results obtained by calculation.

If it is required to apply this chart to a case where wheels are spaced more than 48½ inches between hub faces, the diameter results, as determined by use of the diagram, should be read closely, and the difference between the wheel-seat diameter and diameter at center noted. Then for a new location of the hub face it is a simple question of proportion, as the center diameter D_1 and the wheel-seat diameter D_2 are plotted as though spaced 24¼ inches apart, and the wheel-seat diameter increases in a direct proportion to the increase of the distance of the hub from the center, D_1.

TEN-WHEEL PASSENGER LOCOMOTIVE.

Mexican National Railway.

The photograph reproduced herewith illustrates one of ten interesting ten-wheel locomotives recently built for passenger service on the Mexican National Railway by the Brooks works of the American Locomotive Company. This is a distinctly American locomotive, with details thoroughly modern, including piston valves, an acetylene headlight, etc. The heating surface is large, being 2,754 sq. ft., and the maximum tractive power of the engine is 28,000 lbs., which, with the adhesive weight of 133,000 lbs., will ensure the maximum drawbar pull under the average condition of rails without the use of sand. A notable feature of this locomotive is the size of the tender, which has a capacity of 7,000 gallons of water and 12 tons of coal. This would seem to be about the limit of size for passenger service.



New Ten-Wheel Passenger Locomotive—Mexican National Railway.

The following table will present the principal dimensions of this locomotive:

Ten-Wheel Passenger Engine.
Mexican National Railway.

Gauge	4 ft. 8½ ins.
Fuel to be used	Bituminous coal
Weight, total	172,000 lbs.
Weight in driving wheels	133,000 lbs.
Weight on leading wheels	39,000 lbs.
Weight, tender loaded	140,000 lbs.

General Dimensions.

Wheel base, driving	14 ft. 6 ins.
Wheel base, total, of engine	25 ft. 7 ins.
Wheel base, total, engine and tender	56 ft. 3½ ins.
Length over all, engine	39 ft. 4 ins.
Length over all, total, engine and tender	66 ft. 3 ins.
Height, center of boiler above rail	8 ft. 9 ins.
Height, stack above rail	14 ft. 11½ ins.
Heating surface, firebox	177 sq. ft.
Heating surface, arch tubes	23 sq. ft.
Heating surface, tubes	2,553.7 sq. ft.
Heating surface, total	2,753.7 sq. ft.
Grate area	35.15 sq. ft.

Wheels and Journals.

Wheels, leading, diameter of	33½ ins.
Wheels, driving, diameter of	68 ins.
Wheel centers, material of	Driving wheels, cast steel
Wheel centers, material of	Engine truck wheels, cast iron, spoke center
Journal, leading axles	5½ ins. x 12 ins.
Journal, driving axles	9 ins. x 12 ins.

Cylinders.

Diameter of cylinders	20 ins.
Stroke of piston	28 ins.
Piston rod, diameter	3¾ ins.
Tractive force	28,000 lbs.

Valves.

Valves, kind of	Improved piston
Valves, greatest travel	5 15-32 ins.
Valves, steam lap (inside)	1⅛ in.
Valves, exhaust clearance (outside)	0
Lead in full gear	1-16 in.
Steam ports, length	25¼ ins.
Steam ports, width	1⅞ in.

The 1902 report of the Board of Railroad Commissioners of the Commonwealth of Massachusetts, with the returns of 1901, has been received. The intereseting fact is revealed that there are over 1,900 miles of street-railway line in that State, which is only 200 miles less than the total mileage of main and branch lines of the steam railroads in Massachusetts.

Mr. Philip T. Lonergan has resigned as division superintendent of motive power of the New York Central to become superintendent of motive power of the Rutland Railroad.

Mr. A. Lovell has resigned as superintendent of motive power of the Northern Pacific, and will succeed Mr. W. A. Nettleton as assistant superintendent of motive power of the Santa Fe. Mr. A. E. Mitchell, of the C. M. & St. P. Ry., succeeds Mr. Lovell on the Northern Pacific.

Mr. John Mackenzie has resigned as superintendent of motive power of the Nickel Plate and is succeeded by Mr. W. L. Gilmore.

Mr. J. M. Robb has resigned as master mechanic of the Virginia & Southwestern Railway to accept the position of superintendent of motive power of the Canadian Northern, with headquarters at Winnipeg. Mr. Robb is succeeded upon the Virginia & Southwestern by Mr. John B. Camden.

Exhaust ports, least area	65 sq. ins.
Bridge, width	2 ins.

Boiler.

Boiler, type of	Extended wagon top, radial stayed
Boiler, working pressure	200 lbs.
Boiler, material in barrel	Steel
Boiler, thickness of material in shell	9-16 in., ⅝ in., ½ in., 11-16 in.
Boiler, thickness in tube sheet	¾ in.
Boiler, diameter of barrel front	67⅞ ins.
Boiler, diameter of barrel at throat	75½ ins.
Seams, kind of horizontal	Sextuple
Seams, kind of circumferential	Double

Firebox.

Firebox, length	124 ins.
Firebox, width	42 ins.
Firebox, depth, front	77 ins.
Firebox, depth, back	60 ins.
Firebox, thickness, sheets	Crown ⅜ in., tube ⅝ in., side ⅜ in.
Tubes, number of	348
Tubes, material	Charcoal iron
Tubes, diameter outside	2 ins.
Tubes, thickness	12 B. W. G.
Tubes, length over tube sheets	14 ft. 1 5-16 ins.
Smokebox, length from tube sheet	64½ ins.
Exhaust nozzle	Single, not variable; 5¾ ins. diameter

Tender.

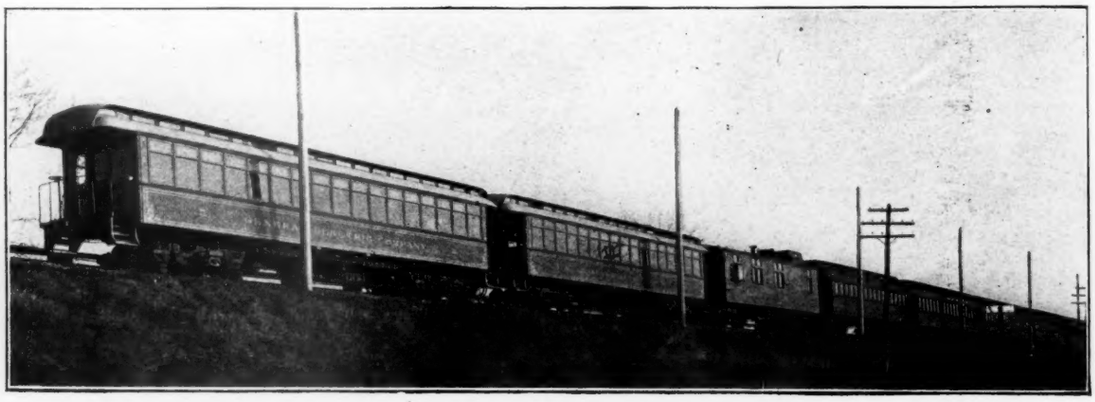
Tank, type	Gravity water bottom
Tank, capacity for water	7,000 gallons
Tank, capacity for coal	12 tons
Tank, material	Steel
Type of under frame	Steel channel
Type of trucks	American basic steel bolsters
Diameter of wheels	33⅛ ins.
Diameter and length of journals	5½ x 10 ins.

COMPARATIVE ACCELERATION TESTS WITH A STEAM LOCOMOTIVE AND ELECTRIC MOTOR CARS.

By B. J. Arnold and W. B. Potter.

In connection with the preparation of a report [the report appearing on page 251 of our August issue.—Ed.] on the use of electricity for the propulsion of trains of the New York Central Railroad in the tunnel entrance and terminal in New York City, an invitation was extended by the General Electric Company to Mr. W. J. Wilgus, chief engineer of the railroad company, to use its experimental track and apparatus at Schenectady, and a series of tests were accordingly carried out, principally for the purpose of determining a comparison between steam and electric traction on short-haul suburban passenger service. The short curves in the connecting tracks prevented the General Electric Company's track from being used for the steam locomotive tests, so that the steam tests were made on the New York Central main-line tracks west of Schenectady.

(The steam locomotive used in these tests was the very heavy 6-coupled suburban locomotive which was recently built for the New York Central from the specifications of Mr. A. M. Waite, superintendent of motive power and rolling stock, by the Schenectady Locomotive Works, and which was illustrated and described on page 115 of our April, 1902, issue.) This locomotive was designed specially for the rapid acceleration work required in suburban service, being provided with large grate area and heating surface and a very large proportion of weight on its driving wheels.



Electric Train Used in the Comparative Acceleration Tests.—(The two forward cars are the motor cars.)

The two electric motor cars used for the electrical tests were similar in form, 54 feet over all, each weighing about 35 tons including the electrical equipment, which consisted of four General Electric 55 motors and type M control. All axles being equipped with motors, the two cars together gave approximately the same weight upon the drivers as the steam locomotive. The acceleration was, therefore, directly comparable for trains of equal net weight, and, to secure this comparison, the same trail cars, arranged in the same order, were used in both the steam and electric tests. In the steam-runs the drawbar pull, speed and time were recorded by the Illinois Central dynamometer car, and the same car was used with the electric motor cars to determine the relation between the current input in amperes and the drawbar pull.

The order of the tests, both steam and electric, was as follows:

A train of six cars, including five standard New York Central passenger coaches and the dynamometer car, was started and run over a mile of track, acceleration being made as rapidly as possible. These runs were repeated, dropping off one car at a time, until only the dynamometer car remained. Automatic records were kept of the drawbar pull, speed, time, distance, and the strength and direction of the wind. The condition of rail and temperature was also noted. The same runs were repeated, using the two electric motor cars in place of the steam locomotive, additional records being kept of voltage, ampere and wattmeter readings. The wattmeter was not carried on the car, but was placed stationary at the point of feeding the third rail, thus avoiding any inaccuracy due to jarring. The voltage leads of the watt-

* Abstract of a paper read before the June convention of the American Institute of Electrical Engineers at Great Barrington, Mass.

It is undoubtedly the desire of every one of our readers to occasionally, if not frequently, purchase books upon engineering and scientific subjects, but the selection of the most suitable book from those offered by the publishers is most difficult if one is not able to see the books personally. It has been truly said that "titles of books are very misleading," as they are so in many cases, as one finds upon ordering a book without seeing it in advance. An innovation is offered in this line, however, by the Derry-Collard Company, recently formed with offices at No. 256 Broadway, New York. This company proposes to make selections of books, to the best of their judgment, for those stating to them their wants and desires with respect to the purchase of books, and will forward the book selected to the purchaser for examination, whereupon he may pay for same if it is suitable, or return it if it is not just what is wanted. Any book published will be procured, and will be sent to anyone without any references and without any extra charge for the service. This proposition appears to be a boon to those desiring to purchase technical books, and we feel sure that the best of selections will be made owing to the technical ability incorporated in the officers of the company.

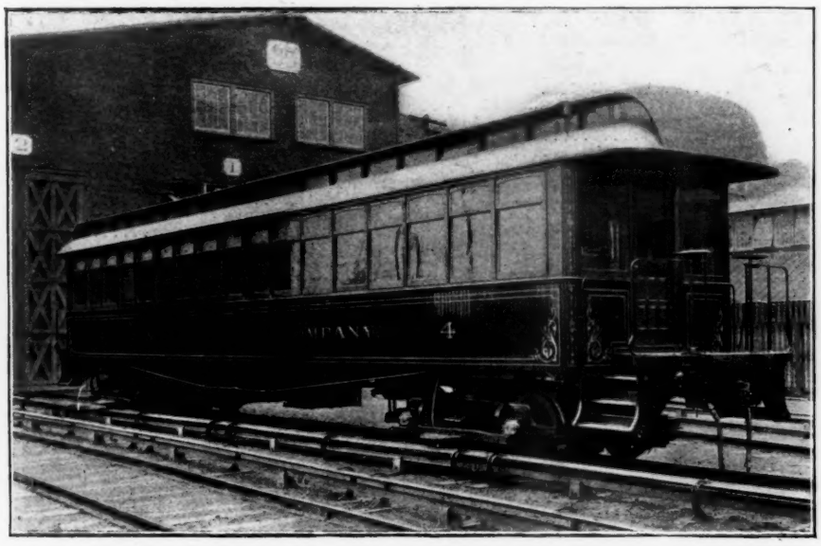
Mr. F. J. Kraemer has been appointed master mechanic of the Wyoming division of the Burlington & Missouri River, with headquarters at Alliance, Neb., to succeed Mr. J. P. Reardon. Mr. A. B. Pirie has been made master mechanic of the Southern division, with headquarters at Wymore, Neb., to succeed Mr. Kraemer. Mr. W. F. Ackerman succeeds Mr. Pirie as master mechanic of the Havelock shops. Mr. C. S. Bricker succeeds Mr. Pirie as piecework inspector.

meter were connected to the extreme end of the third rail and track, thus receiving at all times the exact voltage at the train, so that the energy delivered to the motor cars represented the net input and did not include losses in the feeder system.

The Electric Runs.—Electric Motor Cars Nos. 4 and 5.

The electric runs were made upon the General Electric experimental track against a head wind of 15 m. p. h. The rail was dry, the temperature 8 degrees C., and the grade practically level. In the middle of the run there was a curve having a minimum radius of 875 feet, equivalent to about a 6½-degree curve, the effect of which may be assumed as approximately equivalent to the 1 per cent. up grade met on the steam runs.

No. of run.	Character of load.	Weight of load, tons.	Total weight train, tons.	Maximum speed.	Average speed.	Watt hours per ton mile. From volt amperes.	Watt hours per ton mile. From watt-meter.
1	6 Trailers	157.	228.5	36.4	27.2	75.9	79.4
3	5 Trailers	130.	201.5	37.9	28.6	78.4	82.0
5	4 Trailers	104.	175.5	39.1	29.8	84.3	86.9
7	3 Trailers	77.	148.5	41.0	30.6	81.7	93.4
9	2 Trailers	47.	118.5	42.8	32.0	98.5	99.4
11	1 Trailer	23.	94.5	44.7	33.1	115.0	114.0
13	No Trailer	...	71.5	46.7	34.6	132.3	129.0



One of the General Electric Co.'s Motor Cars—Used in the Comparative Acceleration Tests.

[This view shows also the Improved Type of Protected Third Rail and Contact Shoe, used on the General Electric Co.'s Test Railroad.]

The Steam Runs.—New York Central Steam Locomotive No. 1407.

All steam locomotive runs were made upon the New York Central main-line track west of Schenectady, against an up grade of 1 per cent. and a head wind of 15 m. p. h. The temperature was 4 degrees C., and the rail wet with a very light falling snow.

No. of run.	Character of load.	Weight of load, tons.	Total weight of train, tons.	Maximum speed, m.p.h.	Average speed, m.p.h.
2	6 Trailers	157.	264.	30.0	28.2
4	5 Trailers	130.	237.	41.3	28.1
6	4 Trailers	104.	211.	40.9	27.4
8	3 Trailers	77.	184.	45.7	27.3
10	2 Trailers	47.	154.	48.0	30.1
12	1 Trailer	23.	130.	50.9	33.0

Although this locomotive was especially built for suburban, or acceleration, work, and was provided with a large firebox, giving it facilities for rapid steaming, the pressure dropped from 200 lbs. to less than 185 lbs. during the first part of acceleration. In starting, the throttle was opened wide and steam used full stroke, the engine being hooked up as acceleration proceeded. Although the steam locomotive was able to give a maximum tractive effort at starting equal to that obtained electrically, this high tractive effort was not maintained, but immediately fell off with increased speed, even with the most expert handling. Even though the electric runs had the advantage of dryer rails than the steam runs, the driving wheels were not slipped in either instance.

(The results of these runs have been represented graphically, as shown in the accompanying engravings. In each run the drawbar pull, the speed, and, in the electric runs, the voltage and amperes per train, have been plotted with respect to the number of seconds after the start, and for ease of comparison the curves for corresponding steam and electric runs have been superimposed, as shown, Steam Run No. 2, upon Electric Run No. 1, etc. In this way direct comparisons of the steam and the electric service may be made.)

As the acceleration curves produced by the steam locomotive and electric motor cars have different shapes, and as in the two tests there was about the same weight upon the drivers, it is interesting to note how well this driver weight was utilized. This is shown by the following tables giving the speed reached in ten, twenty and thirty seconds with equal trailing load for both electric and steam trains.

Miles Per Hour Attained in 10 Seconds.

Number of trailers	1	2	3	4	5	6
Motor cars No. 4 and 5	22.5	20.7	17.3	14.4	12.6	11.
Locomotive No. 1407	14.	13.	12.5	12.	10.	9.7

Miles Per Hour Attained in 20 Seconds.

Number of trailers	1	2	3	4	5	6
Motor cars No. 4 and 5	34.	32.3	29.4	27.4	24.5	21.2
Locomotive No. 1407	25.	21.2	21.5	19.5	18.	16.3

Miles Per Hour Attained in 30 Seconds.

Number of trailers	1	2	3	4	5	6
Motor cars No. 4 and 5	38.2	36.4	34.2	32.	30.3	28.1
Locomotive No. 1407	31.7	26.2	27.	24.7	23.2	20.8

An inspection of the above tables and diagrams brings out clearly the fact that the electric motors can during acceleration more effectively utilize the weight upon their drivers than a steam locomotive. As rapid acceleration is especially important when stops are a mile or so apart, the electric motor has an advantage in being able to cover the same distance in the same time with less energy expended and at less maximum speed than with the steam locomotive, owing to its being able to maintain its maximum accelerating rate for a longer period.

The average speed given in both steam and electric tables is the average speed of the train while it is in motion, and does not include time of any stop at the end of the run. Starting from rest, the power was kept full on to the three-quarter mile post, where the power was shut off and the brakes applied in such a manner as to bring the train to rest as near the mile post as practicable. In the tests the steam train ran from 5 to 15 per cent. over a mile before the train was brought to rest, and the electric trains from 2 to 4 per cent.; but even with the longer distance, the average speed of the steam runs only approaches that attained in the electric runs made over a shorter distance. A comparison of the two sets of runs on the basis of average speed is therefore not quite fair to the electric motor car, as its average speed would have been considerably higher if the length of the run had been the same as that made with the steam locomotive. An inspection of the tables will show, however, that even with the shorter distance run the electric motor cars were able to make higher average speeds than the steam locomotive over its longer distance, and these higher average speeds were obtained also with a lesser maximum speed.

The maximum speed of a train making a given run in a given time serves as an indication of its energy consumption. A train, therefore, which is so handled as to make a given run in a given time, with lowest maximum speed, will consume less energy for the run. The electric runs tabulated all show a lower maximum speed and a higher average speed than those runs made with the steam locomotive, and the energy consumption of the electric runs should therefore be less for the same service performed than with the steam locomotive.

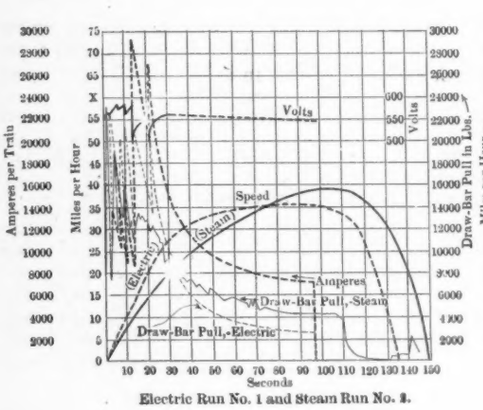
The motors of an electrically equipped train may be placed upon the trucks of ordinary passenger coaches, each carrying its full complement of passengers, and thus lessen the gross weight of each train by elimination of the locomotive; also, in reality, the true measure of comparison between steam and electrically propelled trains should be the energy per seat mile rather than per ton mile, as the latter is based upon the total train weight, and includes a considerable proportion of dead weight embodied in locomotive and tender. The weight of the electric motors is much

less than the weight of a steam locomotive capable of performing the same service, as the latter, in addition to its tender, must be heavy enough upon its drivers to provide a drawbar pull sufficient to accelerate the train.

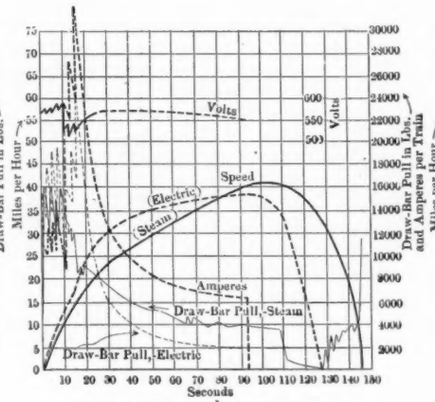
As an illustration, the following table has been prepared from these tests, showing the number of cars in the train, the number of passengers carried (each car seating 64 people), and the energy,

Efficiency of Electric Runs.

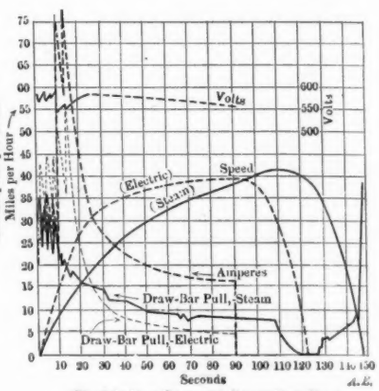
Trailers.	Average m.p.h.	Watt hours per ton mile, Output.	Watt hours per ton mile, Input.	Efficiency of run.
6	27.2	59.1	79.8	74. %
5	28.6	61.0	82.0	74.3%
4	29.8	63.8	84.9	75.3%
3	30.6	68.0	90.2	75.3%
2	32.	69.6	99.6	69.9%
1	33.1	75.3	112.8	66.7%
0	34.6	79.8	130.0	61.5%



Electric Run No. 1 and Steam Run No. 2.



Electric Run No. 3 and Steam Run No. 4.

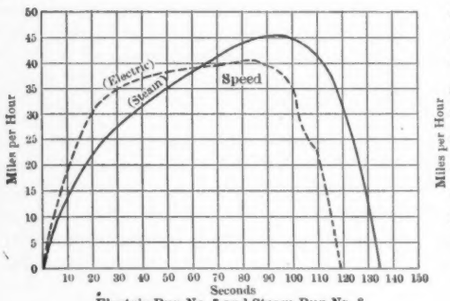


Electric Run No. 5 and Steam Run No. 6.

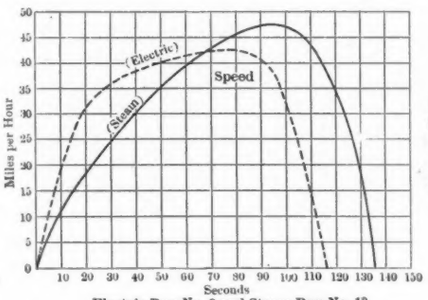
Electric	6 Trail Cars.
Weight	157 tons
Weight, including motor cars	228.5 tons
Power on	4,170 ft.
Distance run	5,380 ft.
Watt-hours per ton mile	79.4
Steam	6 Trail Cars.
Weight	157 tons
Weight, including locomotive	264 tons
Power on	4,035 ft.
Distance run	6,150 ft.

Electric	5 Trail Cars.
Weight	130 tons
Weight, including motor cars	201.5 tons
Power on	4,170 ft.
Distance run	5,380 ft.
Watt-hours per ton mile	82
Steam	5 Trail Cars.
Weight	130 tons
Weight, including locomotive	237 tons
Power on	4,270 ft.
Distance run	6,050 ft.

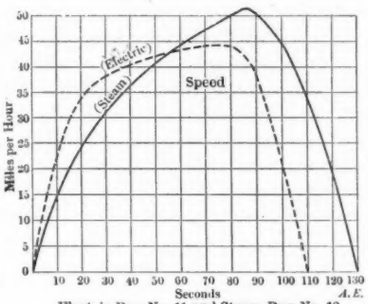
Electric	4 Trail Cars.
Weight	104 tons
Weight, including motor cars	175.5 tons
Power on	4,135 ft.
Distance run	5,380 ft.
Watt-hours per ton mile	86.9
Steam	4 Trail Cars.
Weight	104 tons
Weight, including locomotive	211 tons
Power on	4,490 ft.
Distance run	5,943 ft.



Electric Run No. 7 and Steam Run No. 8.



Electric Run No. 9 and Steam Run No. 10.



Electric Run No. 11 and Steam Run No. 12.

Electric	3 Trail Cars.
Weight	77 tons
Weight, including motor cars	148.5 tons
Power on	1,470 ft.
Distance run	5,370 ft.
Watt-hours per ton mile	93.4
Steam	3 Trail Cars.
Weight	77 tons
Weight, including locomotive	184 tons
Power on	4,520 ft.
Distance run	5,930 ft.

Electric	2 Trail Cars.
Weight	47 tons
Weight, including motor cars	118.5 tons
Power on	4,100 ft.
Distance run	5,490 ft.
Watt-hours per ton mile	99.4
Steam	2 Trail Cars.
Weight	47 tons
Weight, including locomotive	154 tons
Power on	4,455 ft.
Distance run	5,927 ft.

Electric	1 Trail Car.
Weight	23 tons
Weight, including motor cars	94.5 tons
Power on	4,060 ft.
Distance run	5,350 ft.
Watt-hours per ton mile	114
Steam	1 Trail Car.
Weight	23 tons
Weight, including locomotive	130 tons
Power on	4,460 ft.
Distance run	6,260 ft.

which for convenience we have given in watt hours, required per passenger, for both steam and electric runs.

Net Energy Per Passenger Carried.

Number of Cars.	Number of Passengers.	Watt Hours per Passenger Steam.	Watt Hours per Passenger Electricity.
6	384	43.9	29.7
5	320	52.2	32.1
4	256	57.5	33.5
3	192	77.4	37.5
2	128	103.0	45.2
1	64	187.8	45.2

This table is based upon the actual net energy delivered to the wheels of the train, and does not include the losses inherent to any system of operation. The results tabulated may, therefore, be considered as fundamental, and typical of the two systems of operation—the steam locomotive and the electric motor car.

The following table gives the efficiencies for the seven electric runs, the efficiency being the ratio between net energy output to the wheels and total volt ampere input:

An accurate comparison of the relative efficiency or coal consumption of steam and electric power for similar service would require an extensive series of tests with indicator and dynamometer on the performance of the steam locomotive. But as a matter of interest we have secured an approximate comparison from a single test by weighing the coal and water taken by steam locomotive No. 1407 for a period of 24 hours, covering four trips between North White Plains and Grand Central Station, a distance of 24.75 miles, on the Harlem division of the New York Central. The trips occupied about 4 hours, the yard movements about 1 hour, and the locomotive was idle for 19 hours. The following is a detailed record:

North White Plains to Grand Central Station.

Time.	Number of Cars.	Number of Stops.	Total Weight.	Weight of Cars.	Effective H.P. Hours.
63.5 min.	3	21	204 tons	97 tons	129
Lay-over	6 hours.				

Grand Central Station to North White Plains.

Time.	Number of Cars.	Number of Stops.	Total Weight.	Weight of Cars.	Effective H.P. Hours.
66.25 min.	5	17	278 tons	171 tons	255
Lay-over.....	12 hours.				

North White Plains to Grand Central Station.

Time.	Number of Cars.	Number of Stops.	Total Weight.	Weight of Cars.	Effective H.P. Hours.
60.3 min.	7	13	387 tons	280 tons	231
Lay-over.....	¾ hours.				

Grand Central Station to North White Plains.

Time.	Number of Cars.	Number of Stops.	Total Weight.	Weight of Cars.	Effective H.P. Hours.
59.75 min.	4	20	256 tons	149 tons	246
Lay-over.....	1¼ hours.				

Total effective H.P. hours hauling coaches	861
Coal consumed	13,412 lbs.
Coal per effective H.P. hour	15.6 lbs.

The effective H. P. hours given above is the energy required for movements of the cars only, exclusive of the locomotive, and was determined from the drawbar pull taken by dynamometer car in previous tests over the same route. The coal consumption covers all coal burned during the period of 24 hours, not only for movement of cars, but also movement in the yard and the banking of fires during lay-overs.

The effective H. P. hours to move the cars serves as the basis of comparison with electric service, the coal consumed by the locomotive for whatever purpose being properly chargeable to the net work done by the locomotive during the period.

The efficiency of an electrical system, as an average under variable load, may reasonably be assumed as follows:

	Efficiency, Per Cent.
Engine	90
Alternator	92
High potential transmission	98
Transformers	97
Converters	92
Third rail	95
Motors, including control	75
Resultant efficiency	51.33

This percentage of effective horse-power output of motors to indicated horse power of engine will vary somewhat, depending on the load factor. As an even figure, we will assume an efficiency of 50 per cent. Coal consumption per indicated horse-power hour, from actual records of electric power stations, is in some cases less than 2 lbs., the average being about 2½ lbs. At the latter figure, the coal per effective horse-power hour output of electric motors would be 5 lbs. Assuming the head-end air resistance as 10 per cent., and as the electrical equipment would increase the weight of the cars about 20 per cent., the actual comparison of coal consumption would be approximately in the ratio of 6.6 for electric and 15.6 for steam.

Assuming that coal for a power station can be purchased for 80 per cent. of the cost per ton of that used in the locomotives, and that the cost of coal for electrical power is about one-third of the total cost, including maintenance and interest on investment, it is probable that the actual gross cost of electrical power would closely approximate the coal consumption of a steam locomotive in this class of service, the maintenance of the electrical equipment and attendance required being, however, considerably in favor of the electric power.

LEAKS IN CAR WORK EXPENSES.

Mr. G. W. Rhodes opened a discussion of the possible opportunities of the savings in connection with car work (at Saratoga in June) by comparing railroad methods with the use of meters by municipal water companies to stop the waste of water. Continuing, he said:

"A railroad company furnishes all its supplies without meters, and the wastes that consequently occur are simply enormous. Let me cite a few cases that may be seen almost any day. What justifies a railroad company in allowing its locomotives to run with their headlights lit at 1 or 2 o'clock in the afternoon? Go to any union depot on a bright sunny day at 2 and 3 o'clock in the afternoon and it is not unsual to find headlights lit. Why? Simply because there is no meter. We would not allow such a waste at home because we would have to pay for the oil. On a railroad, where oil is obtained simply by asking for it, it is a quite sufficient excuse to say the train does not stop when it begins to get dark, or else that we are traveling in a windy country, and, therefore, cannot light the headlight out of doors. Such an argument goes with the average railroad man, although it is equally well known that by folding and dropping a lighted discarded train order down the chimney of the headlight the lamp can be lit in the strongest gale of wind.

"Take again the matter of lights in coaches. At our homes nobody thinks of lighting lamps an hour or two before it is dark, but there is hardly a railroad that does not have its lights lit while the sun is still shining. Recently in going east from Chicago the Pintsch gas was turned up in the sleeper in which I sat while in the depot, which was all right, as the depot was dark. As soon as we got out of town the sun was shining brightly, but the 24 burners in the car were all allowed to remain burning turned on full. No one would have thought of such extravagance anywhere excepting on a railroad. No check was kept on the gas consumed and no one at the end of the month was any wiser whether much or little was used. Many other cases might be cited if time permitted.

"The remedy for this and similar wastes is a more general use of meters; the only meter that is practicable on a railroad is railroad accounts. We have not a great deal of information as to just what the various departments of a railroad ought to cost. Some railroad men are better informed on these matters than others, and know by looking over the meters, or accounts, whether improvements can be made or not. Let us consider for a moment the question of car oil. A few years ago it was considered remarkably cheap with oil costing 20 cents per gallon to lubricate freight car equipment for 8 cents per 1,000 miles. The railroad official to-day who does not keep his cost of freight car oil down to an average of 4 to 6 cents per 1,000 miles is laying himself open to a great deal of criticism. A reduction in freight car lubrication, with oil at 20 cents per gallon, from 12 cents per 1,000 miles to 4 cents per 1,000 miles on a railroad of 4,000 miles extent, is the equivalent of a saving of $8,000 per year, a figure that is well worth the expense of an intelligent meter.

"The substitute for meters in railroad work then is carefully compiled accounts. I well know that operating men are too busy to be in full touch with the many accounts on a railroad, but we have able help in this matter in the auditing department, and I would urge car men and machine shop men to keep in close touch with the auditing department. Get them interested in showing how our meters read. They have charge of a most important department, and it is available to all of us if we will use it. The most successful railroad of to-day is the one that can operate cheaper than its neighbor. This is what has given this country its commanding commercial position among nations. Through our economical methods of production and of transporting we are able to invade the markets of every continent throughout the world. I therefore urge the members of our association to be untiring in watching the meters of their department and stop some of the wastes that even at the present time are so glaringly prominent on many of our best railroads."

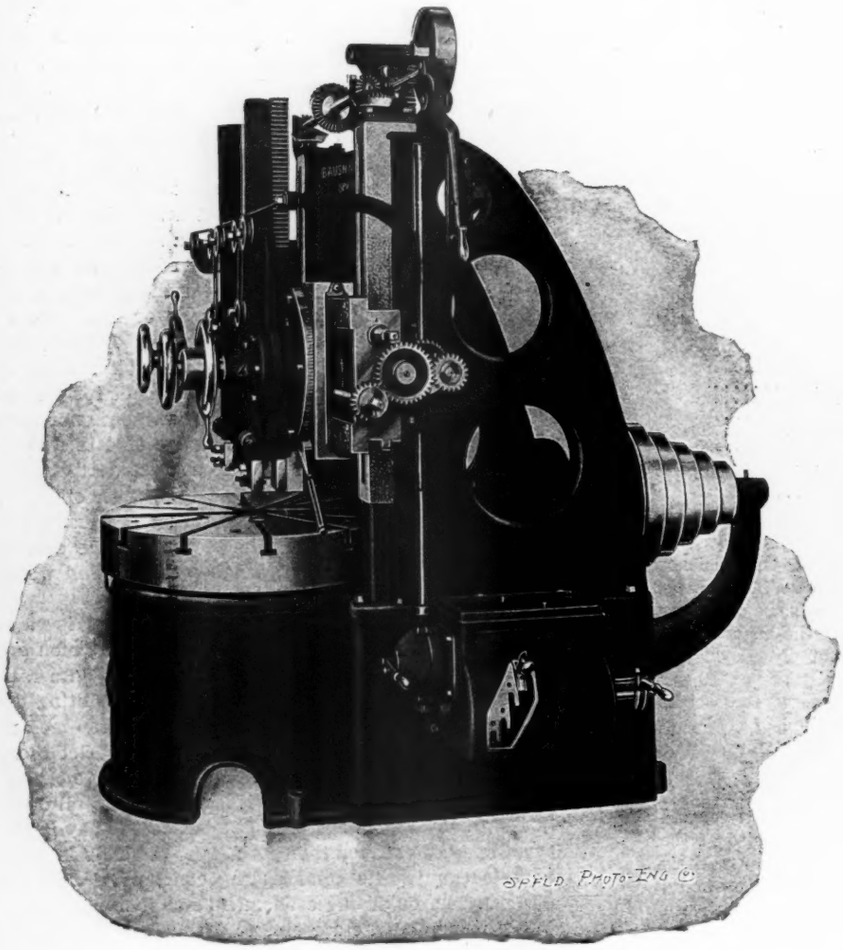
The M. C. B. coupler, in spite of its faults, will stand as a remarkable piece of work of the Master Car Builders' Association. Up to the present it has stood tests of service which could not have been foreseen by those who made it standard, and it has stood well. Its general use brings a serious difficulty, however, as it becomes evident that greater strength is now needed, and at the recent convention the Committee on Coupler Tests suggested a change in the contour to permit of the use of 1¾-inch knuckle pins, this change to be made very gradually, to avoid interference of contours, which would defeat the very object of the standard contour. The history of the M. C. B. coupler as to contours and the lack of conscientious following of the standard lines by the manufacturers does not inspire confidence in this method of securing the necessary additional strength. It is not at all likely that hasty action will be taken in this direction, and before anything is done a better way out of the difficulty may be found. Such a way has already been brought to the attention of this journal and it will be put before the readers in a short time.

A NEW BORING AND TURNING MILL

The trend of progress in machine-shop methods has brought the boring mill into nearly as great importance as the lathe. The large number of operations that can be made on a boring mill to far greater advantage than in the lathe, both for boring and for turning, should bring the boring mill into much more extensive use in railroad shops.

The accompanying engraving is an illustration of an improved type of boring mill recently brought out by the Bausch Machine Tool Company, Springfield, Mass., which embodies many important new features, adding greatly to its economic value as a machine tool. One of the most important features of this tool is the addition of positive-drive feeding mechanisms, of which there is an independent mechanism for each of the two heads of the machine, thus rendering different rates of feed possible for the tool in each head. These gear mechanisms, one of which is shown located at the lower right-hand side of the machine, are adaptations of the well-known Hendey-Norton variable-speed gearing device, which consists of a cone of gears of differing sizes and a gear movable upon a splined shaft and capable of being thrown into mesh with any gear of the cone. Power for the feeds is delivered through vertical splined shafts, which engage with feed gears on the cross-rail. By this means fifteen changes of feed at the heads, ranging from 1-64 to 9-16 in., for vertical, and from 1-64 to ⅞ in., for horizontal, per revolution of the table are possible, and may be made almost instantly and without stopping the work. This method of changing the feeds has great advantages over the belt and cone-pulley method, even in view of the fact that the gear-drive will not spare the tool as the slipping of a belt will in a belt-drive.

The back gears of this machine are arranged to be thrown in or out by means of a lever, thus avoiding the use of the lock-nut, another unquestionable saving of time. The cross-rail is arranged to be rapidly raised and lowered by power controlled by the lever shown at the top of the frame, and the heads, besides being operated and adjusted independently, are provided with split nut arrangements permitting them to be moved back and forth very rapidly for quick adjusting to the work.



The New Bausch Boring Mill.

The table may be removed and replaced by either an independent or universal chuck, all being interchangeable. The main spindle bearing is very large and long, and is provided with a self-oiling device. These mills may be changed over for direct motor-driving by simply removing the cone pulley and bearing, and connecting up in their place on the bed a suitable electric motor.

Among some of the machining operations to which the boring and turning mill is particularly adaptable may be mentioned: Turning, facing and boring all special, irregularly shaped castings, which are very difficult to chuck in a lathe, such as gate-valve castings, large, rectangular-shaped castings, cylinder heads, etc.; also, large, thin rings may be easily handled, and special operations may often be expediently handled, such as boring a casting with a tool in one head and facing or turning another part of the casting with the other head. No trouble is experienced with the boring mill if the work is entirely out of balance, as there is with the lathe.

The development of the alcohol industry in Germany is fostered by the government, because of the lack of petroleum deposits in that country. Denaturized alcohol, suitable for industrial purposes, is free from tax, whereas the alcohol for drinking is highly taxed. The result has been a great increase in the product from potatoes and other cheap sources. It has led to a development of the alcohol engine, which is important as well as interesting.

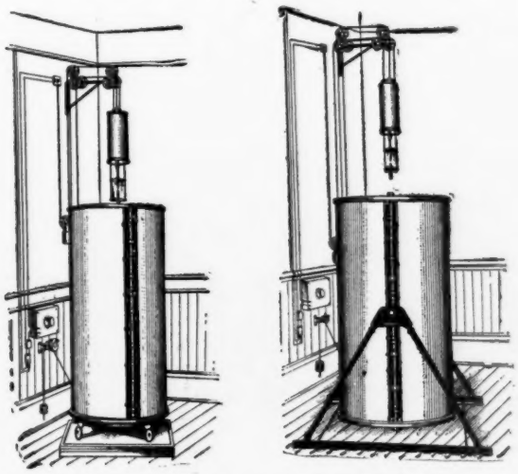
Mr. A. G. Wells has recently been appointed general manager of the Coast lines of the Santa Fe system, with headquarters at Los Angeles, Cal. He has made the following appointments: F. J. Shepard, general superintendent of the Coast lines; R. B. Burns, chief engineer, and G. R. Jougins, mechanical superintendent.

Mr. W. E. Cavey and Mr. C. F. Richardson have recently been appointed to the positions of general road foremen of engines of the Baltimore & Ohio, with their headquarters at Baltimore.

Mr. Allan Bourn, of the New York Central & Hudson River Railroad, has resigned his position as purchasing agent, which position he has held since 1891, when he came from the Michigan Central.

AN ELECTRIC LIGHT BLUE-PRINT MACHINE.

Blue-printing has been rendered entirely independent of rainy, cloudy and dark days by the electric light blue-print machine. The cylindrical electrical copier, two views of which are shown in the accompanying illustrations, permits blue-printing to be done at night as easily as in bright sunlight. It consists essentially of a cylinder of plate glass, made in halves longitudinally, and an electric arc lamp with means for lowering it down through inside the cylinder. The tracing and sensitized paper are wrapped, facing inward, around the outside of the cylinder and held in place by stout canvas covers. The lamp is then released and descends slowly through the cylinder at a speed regulated by a pendulum and escapement, the escapement being driven by the lamp-supporting cord, which wraps around a drum connected to the escapement wheel. The lamp needs to go down but once for an exposure, and on reaching the bottom is quickly withdrawn by winding up the cable.



The Pittsburgh Electric Light Blue-Print Machine.

The speed of the lamp's movement, and hence the time of the exposure, is adjusted to suit different brands of paper by properly setting the pendulum bob on its rod and thus altering the length of the pendulum. The upright at one of the joints in the glass cylinder carries some horizontal flat steel springs, to the ends of which vertical strips of wood are attached, which act as clamps to hold the first edge of the tracing and sensitized paper. The sheets of canvas are attached to the same upright under the springs. To the free edges of the canvas are attached, by tension springs, a number of hooks which hook over a metal rod on the upright at the opposite joint in the glass—shown at the front side in these views. The spring hooks insure an even pressure everywhere and give the best possible conditions for securing perfect contact.

To save walking around the machine, one form of the copier, shown in the left-hand accompanying view, is placed on rollers, so that it may be easily revolved. A cast-iron floor-plate is provided, a spindle in the center of which keeps the machine in position on the base. In the other form—the tilting type shown in the right-hand cut—the glass cylinder is arranged to tilt down to a horizontal position, and is specially adapted for small prints. The machines are made in various sizes, accommodating tracings from 30 x 42 ins. in the smallest to 42 x 84 ins. in the largest. Each tracing occupies but one-half of the cylinder, so that two prints may be made at once.

It is, of course, obvious that by the present plan the strength of the light and consequently the printing are precisely equal and uniform on all parts of the tracing, and as the light is close to the surface its action is rapid, two prints 42 x 60 ins. being made in from 2½ to 3 minutes.

These machines are made in all the sizes and with arc lamps adapted for any circuit, by the Pittsburg Blue Print Company, No. 1505 Park Building, Pittsburg, Pa.

EQUIPMENT AND MANUFACTURING NOTES.

The Standard Roller Bearing Company, Philadelphia, Pa., have recently made two important acquisitions—first, in the purchase of the entire business, patents and good will of the Grant Roller Bearing Company, Springfield, Ohio, and, second, in the later purchase of the Roller Bearing and Equipment Company, Keene, N. H. The Standard company is now prepared to fill all orders for roller and anti-friction bearings as made by these concerns, and will move the machinery of the acquired businesses to their factory at Philadelphia. This gives the Standard company a very large control over the roller-bearing field, both in equipment and because of the large number of patents now owned by them.

The Standard Roller Bearing Company some time ago found their present facilities inadequate to meet the growing demand for their product, and purchased a large and valuable piece of trackage property near the center of the city, about ten minutes' ride from the City Hall, on the main line of the Pennsylvania Railroad, where they will build a large factory for the better accommodation of their acquired interests. The new plant is advantageously situated, and is intended to be a model one in every respect. It will be 200 ft. long and from 100 to 150 ft. wide. The principal buildings will consist of two factories 200 ft. long and 60 ft. wide, of the most improved design and construction. Work has already been started and will be continued, to eventually cover the entire property of about two and one-half acres within a short time. The Ball Bearing Company, recently removed from Boston, will occupy a portion of the new plant. The rapid growth of the Standard Roller Bearing Company is worthy of notice, as it is a remarkable development within so short a time. Credit is due to the merit of the company's product, which includes ball, roller and all kinds of anti-friction bearings for machine construction.

The exhibition of ship-riveting with pneumatic tools which the Chicago Pneumatic Tool Company has been making in Glasgow, Scotland, is proving highly successful. Mr. E. Guennell, for many years superintendent of the Chicago Shipbuilding Company at South Chicago, Ill., is in charge, further assisted by two expert riveters from the Chicago shipyards, and he reports most favorable progress and great interest on the part of the shipbuilders on the Clyde. They are just waking up to the imperative necessity of the use of pneumatic tools in that work to enable them to compete with American shipbuilders, and it is anticipated that practically all of the yards on the Clyde will very shortly be equipped with pneumatic tools. The Chicago company is injecting American methods into its European business, having recently sent Mr. F. D. Johnson, manager of its New York office, to push business there, and has also sent Mr. George H. Hayes to take charge of the mechanical work in its London works. The recent absorption of the International Pneumatic Tool Company, of London, gives the Chicago Pneumatic Tool Company control of the pneumatic tool trade throughout Europe. It will now consolidate the factory of the International Pneumatic Tool Company with its plant already started in London. The company has been compelled to operate two of its factories in America extra time, working at night, and this addition to its London plant will give it a much-needed increase in manufacturing facilities.

The Chicago, Rock Island & Pacific Railway has contracted with the Consolidated Railway Electric Lighting and Equipment Company, of 100 Broadway, New York, for the equipment, with its "Axle Light" system of electric lights and fans, of all the cars now being built by the Pullman company to be used in the new limited trains that go into service November 1 between Chicago and San Francisco via the Rock Island and Southern Pacific. The "Axle Light" system of electric car lighting of this company is now in use on the twenty-hour trains of the New York Central and Lake Shore, and Pennsylvania Limited, and also on the finest trains of the Atchison, Grand Trunk, Chicago Great Western, Missouri Pacific and St. Louis & San Francisco, on the dining-cars of other leading railway lines, and also on all private Pullman cars.

The Ashcroft Manufacturing Company, 85 Liberty street, New York, report that the Tabor steam-engine indicator has been adopted by the Philippine Insular Government as their standard on Class "A" cruisers, fifteen of which have been supplied with these indicators. The selection of the Tabor indicator, after the most careful and exhaustive tests, endorses the claims of the manufacturers that it is recognized as standard in all parts of the world.

The contracts for the new plant of the Cleveland Pneumatic Tool Company have been let, and it will soon be completed and ready for operation. The plant will be equipped with the most modern machinery and appliances for turning out work very rapidly. This company has recently opened offices at 411 Park Building, Pittsburgh, Pa., and at 34 Lemoine street, Montreal, Canada.

The New Britain Machine Company, New Britain, Conn., are sending out a folder descriptive of the band saw accessories of their manufacture. In it are illustrated and described a self-acting vise for use in filing band saws, an "equal-blow" setting band saw blades and the Pineo band saw guide. The "equal-blow" setting machine involves some interesting features worth mentioning. This machine is a device for setting the teeth of band saws by giving a graduated hammer blow on an adjoining right and left hand tooth at the same instant, the blows being, of course, equal and oppositely directed. The saw is held in a self-adjusting vise, allowing for uneven thicknesses of blades, due to brazing, variations of gauge, etc., and the blows are delivered by two hammers, actuated by the same spring, which are pulled back and released for the blow by a crank and cam arrangement. After each blow the vise is automatically released and the blade pulled along the distance of two teeth for the next blow, by a ratchet and detent mechanism. In this way the action is continuous and an entire band saw blade may be set throughout its length in a very short time by merely turning the crank actuating the cam. The machine is built very solidly with a one-piece heavy frame, and is intended for service.

The officials of the Louisville & Nashville Railroad are making plans for the entire reconstruction of the shops at South Louisville, Ky. The plans are very extensive, calling for an expenditure of over $2,500,000, and include a complete system of electrical transmission of power throughout. When the new shops are completed the ground occupied by the old shops will be utilized for an extension of freight yards at that point. It is expected that work on the new shops will be begun this fall, the details being in charge of Mr. T. H. Curtis, mechanical engineer of the road.

The Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio, announce a great increase in trade in their staybolt iron, both hollow and solid, which is giving the best of satisfaction to all users. The great security attaching to the use of their hollow staybolts, which give automatic warning of breaks, is especially emphasized, and it is claimed that a much more efficient and reliable staybolt is secured with the hollow bolt than with the solid bolt having the weakening "tell-tale" holes bored in the ends.

BOOKS AND PAMPHLETS.

The Crane Co., Chicago, Ill., have recently published a 1902 edition of their general catalogue. It is a large 362-page cloth-bound volume, illustrating and listing their entire line of standard, medium and low-pressure valves and fittings and steam engineers' specialties and supplies. It is beautifully executed typographically, and is profusely illustrated by excellent engravings. The Crane Co. has also issued a special catalogue of 95 pages illustrating in an equally tasty manner their extra heavy valves, fittings and pipe work for working pressures up to 250 pounds. In connection with this catalogue they particularly call attention to the fact that the dimensions of their extra heavy valves and flanged fittings have been changed in several particulars from the standards given in previous catalogues, so that in ordering valves and fittings to fit old standard dimensions it is now necessary to specify "old dimensions."

A bulletin has recently been issued by the Consolidated Railway Electric Lighting and Equipment Company, 100 Broadway, New York City, descriptive of their "axle-light" system of supplying electric lights and fans for railway cars. The system is thoroughly illustrated and described, both as to general principle and as to operative details. Considerable attention is given to a description in detail of their interesting regulator, by means of which the axle-driven dynamo does not furnish current to the lighting system or storage batteries until the car has reached a sufficiently high speed to generate the proper voltage. When the speed of the car diminishes, the dynamo is automatically cut out of circuit, and the lighting system is supplied by the storage batteries.

We are pleased to learn that the publishers of the Monthly Official Railway List (sometimes called "the Red List") of Chicago, have won their suit before the Supreme Court of the District of Columbia against the Postmaster-General of the United States, to compel him to reinstate their publication under the second-class mail rates. The court issued a mandamus on the Post Office Department, but the department intimated its purpose to appeal the case, ask to have the appeal act as a supersedeas and continue to oblige the publishers to pay third-class rates until final decision in the highest courts. The department finally receded from the position taken, entered the list again as mail matter of the second class and ordered the excess postage heretofore paid to be refunded.

"Soft Water," Railroad Edition.—This is the title of a catalogue recently issued by the J. S. Toppan Company, No. 77 Jackson Boulevard, Chicago, Ill., descriptive of the water-softening process and apparatus manufactured by the Kennicott Water Softener Company, Chicago, Ill. The advantages of soft water for locomotive use are set forth and the process used described. Several important installations of the Kennicott water-softener are illustrated, and results of the process given as determined by analyses. In the latest patented form the Kennicott softener has the lime-saturator inside the settling tank, which will serve to effectually prevent it from freezing in the coldest weather.

Catalogue "A" of the Riehlé Bros. Testing Machine Company, Philadelphia, Pa., has recently been received. This catalogue illustrates and describes all the vertical screw-power testing machines, hydraulic testing machines, and also some special testing machines, made by this company. For the other testing machines made by this company separate catalogues have been issued, as follows: Catalogue "B," wire-testing machinery; "C," chain-testing machines; "D," foundry testers; "E," spring testers; "F," hydraulic pumps and accessories; "G," cement-testing machines, and "H," marble molding and countersinking machines.

The Boston Belting Company, Boston, Mass., have issued a folder descriptive of fire hose for mill and factory protection. Rubber-lined, cotton-covered hose is supplied for this purpose, and also unlined linen hose for use where it must be kept hung up in dry places. This company also furnishhes all couplings, pipes, reels, spanners, connections and other accessories necessary for such installations, as well as all kinds of mechanical rubber goods of every description.

"The Railway Equipper" is the name of a new monthly bulletin issued by the M. Mitshkun Company, 925 Chamber of Commerce Building, Detroit, Mich., devoted to the interests of contractors and to the buying and selling of locomotives, cars, steam shovels, rails, etc. It will be sent free upon application.

No more entertaining evening can be spent by visitors to New York than at one of the Proctor theaters. A variety of entertainment is offered at the Proctor playhouses, including, as is their custom, vaudeville acts between the acts of the regular play. One feature, the "kalatechnoscope," which is included in every performance at all the Proctor theaters, will be of interest to railroad men, from the continuous moving views of railway trains in motion, or views taken from trains in motion, which are nearly always shown.